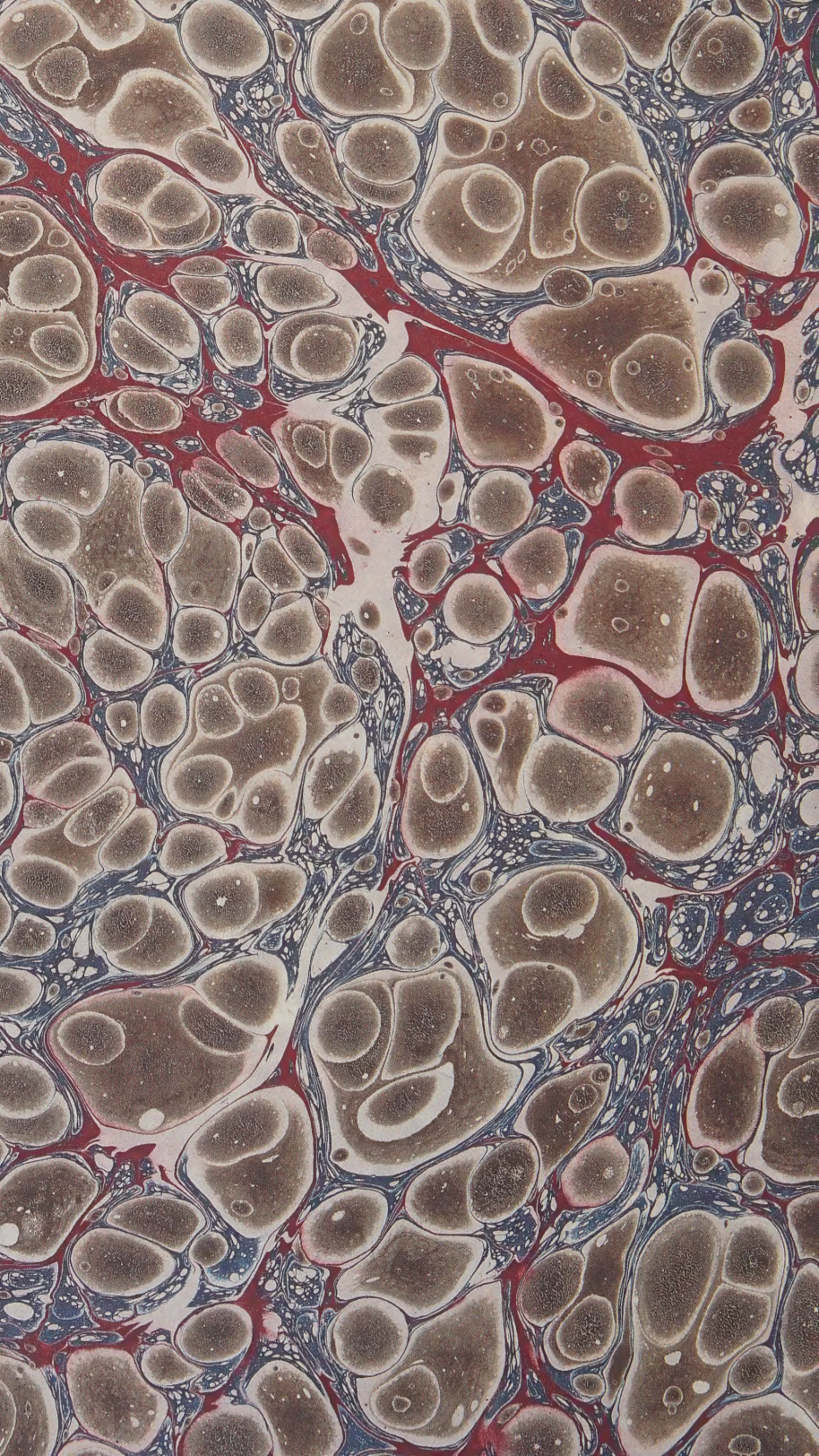

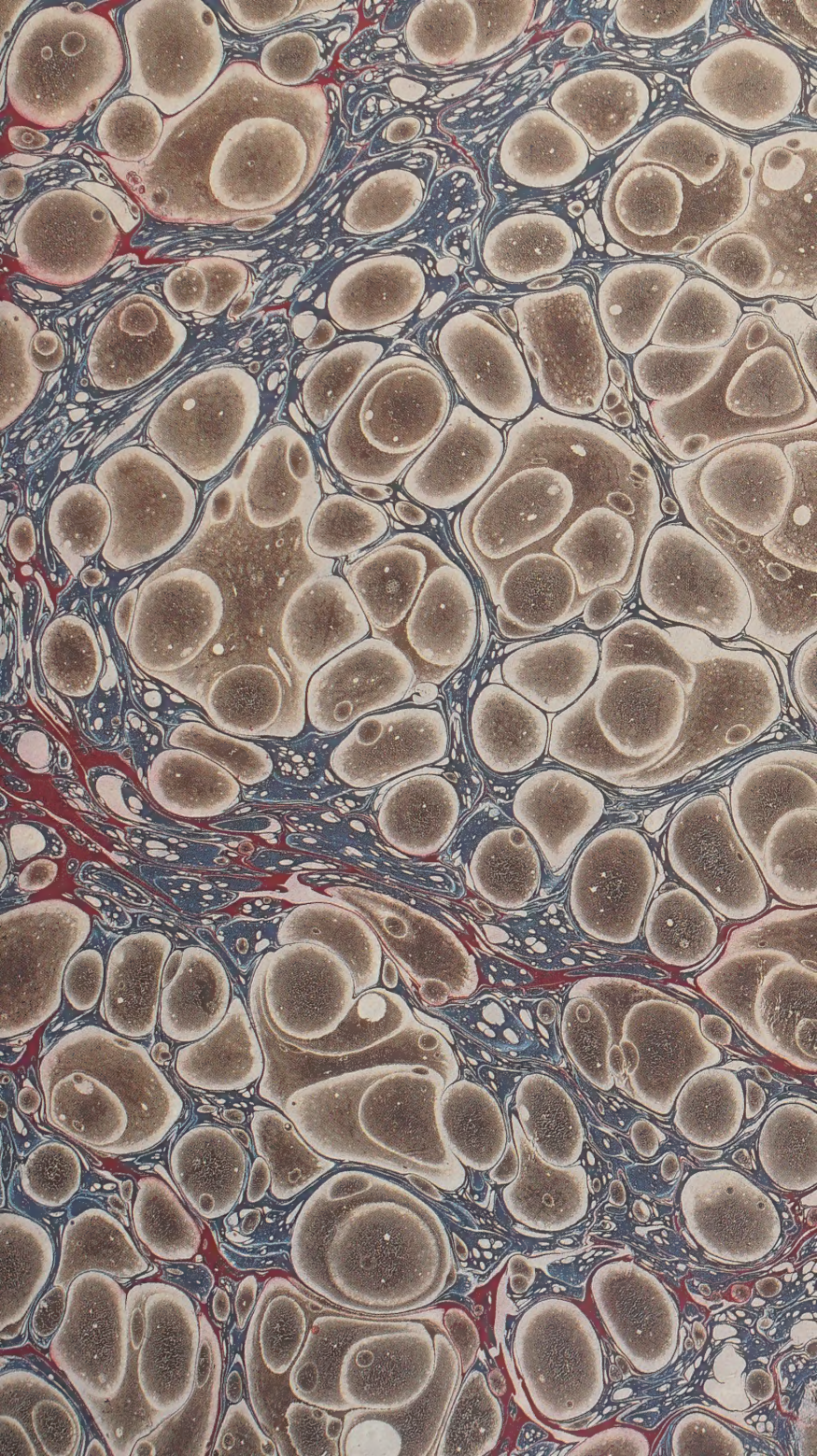

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A TREATISE
ON THE MEMBRANES
By Xavier Bichat

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THIS SPECIAL EDITION OF

A

TREATISE

ON THE

MEMBRANES

BY XAVIER BICHAT

HAS BEEN PRIVATELY PRINTED

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A Treatise on the Membranes

A

TREATISE

ON THE

MEMBRANES

IN GENERAL,

AND ON

DIFFERENT MEMBRANES

IN PARTICULAR;

BY XAV. BICHAT,

OF THE SOCIETIES OF MEDICINE, MEDICAL AND PHILOMATIC OF PARIS; OF THOSE OF BRUSSELS AND LYONS.

A NEW EDITION,

ENLARGED BY AN HISTORICAL NOTICE OF THE LIFE AND WRITINGS OF THE AUTHOR;

BY M. HUSSON.

PARIS, 1802.

TRANSLATED BY

JOHN G. COFFIN, M. D.

BOSTON:

PUBLISHED BY CUMMINGS AND HILLIARD, NO. 1, CORNHILL.

Cambridge....Hilliard & Metcalf.

1813.

District of Massachusetts, to wit:

BE IT REMEMBERED, that on the second day of June, A. D. 1813, and in the thirty seventh year of the independence of the United States of America, CUMMINGS & HILLIARD, of the said district, have deposited in this office the title of a book, the right whereof they claim as proprietors, in the words following, viz.

" A treatise on the membranes in general, and on different membranes in particular: By XAV. BICHAT, of the societies of medicine, medical and philomatic of Paris; of those of Brussels and Lyons: A new edition, enlarged by an historical notice of the life and writings of the author: by M. HUSSON, Paris, 1802. Translated by JOHN G. COFFIN, M D."

In conformity to the act of the congress of the United States, entitled " An act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies, during the times therein mentioned;" and also to an act, entitled " an act for the encouragement of learning, by securing the copies of maps, charts and books to the authors and proprietors of such copies, during the times therein mentioned; and extending the benefits thereof to the arts of designing, engraving, and etching historical and other prints."

W. S. SHAW, { *Clerk of the district of Massachusetts.*

TO

MY FATHER

AND MY BEST FRIEND,

J. B. BICHAT,

DOCTOR OF MEDICINE.

XAV. BICHAT.

To the COUNSELLORS *of the*

Massachusetts Medical Society.

GENTLEMEN,

THE labour of transcribing this volume of BICHAT has been lightened by the persuasion, that you would consider it an important addition to the previous stock of anatomical and physiological knowledge, and by the reflection, that the *Treatise on the Membranes* might, in due time, be honoured with a place in your catalogue of books, prescribed, at stated periods, for the students of medicine in this state.

If on this, or any other occasion, I should ever have reason to believe, that I had contributed any thing to the success of your assiduous and laudable efforts for the improvement and diffusion of medical science, I shall think myself, in no slight degree, fortunate.

I am,

GENTLEMEN,

with sincere respect,

your obedient servant,

J. G. COFFIN.

Boston, June, 1813.

PREFACE.

I HAVE inserted some reflections on the membranes in the memoirs of the Medical Society. They were the abridgement of a larger work, on which I was desirous of consulting the opinion of the learned before their publication.

Some men, for whose judgment I have great respect, received them with an interest, which encouraged me to publish the present work. No one has hitherto engaged in a like enterprise, though medicine and physiology may derive from it decisive advantages. The real chasm which it seems to me to fill, the different experiments it contains, whence I believe useful results may arise, some views suited perhaps to elucidate the theory of the vital powers and of their sympathies, a number of new anatomical facts here laid open, will justify me, I hope, with the learned, in loading a science with one more treatise, on which so much has already been written, and from which there is doubtless more to be retrenched, than now remains to be added.

AN

HISTORICAL NOTICE

OF THE

LIFE AND WRITINGS OF MARIE FR. XAV. BICHAT,

BY M. HUSSON.

READ AT THE MEDICAL SOCIETY OF EMULATION,

28 August, 1801.

Marie Francois Xavier Bichat was born at Thoirette, department of Jura, November 14, 1771, of Jean Baptiste Bichat, doctor of medicine, and of Marie Rose Bichat.

At an early age his parents sent him to the college of Nantua, to pursue his classical studies. The love of labour, his respect for his instucters, his attachment to his school-fellows, then evinced in young Bichat one of those rare beings, who already intimated what in time would be the morals and merit of him, whom we already admire as a pupil.

In 1788 he entered the seminary of St. Yrénée at Lyons, there to finish his studies by a course of philosophy.

In the two schools where he was a pupil, Bichat constantly distinguished himself by his mildness of disposition, his modesty, and his success. Every year he won several prizes at the college of Nantua, and sustained public exercises at Lyons in physics and mathematics, with the highest distinction.

The revolution then paralizing every kind of instruction, Bichat quitted Lyons, returned to his family, and received from his father the first elements of anatomy; but his predominant taste for mathematics led him again to Lyons, where he continued his favourite pursuit, at the same time following his anatomical course, and visiting the great hospital. At length the revolutionary tempest transforming this brilliant city into a vast field of desolation and death, he sought, in the school

of the immortal Desault, a shelter from the persecution which young men of his age then experienced.

Bichat arrived at Paris in 1793. Destitute of every kind of recommendation, abandoned to himself, solely occupied in avoiding the military requisition, in which he was included, he frequents the lectures of Desault, and after a month's residence in Paris, he was at length noticed by this celebrated man. He is soon permitted to perform some dressings in the Hôtel-Dieu; then he read in the amphitheatre, in which the clinical lectures were given, remarks on the sick, whose cure he directed, and he was every where distinguished by his zeal and modesty.

His observations were digested with so much method, precision, and clearness, that Desault was desirous of associating with him talents, whose extent he foresaw, and which could so powerfully serve an art which he himself cultivated with so much eclat. He admitted Bichat to his house, adopted him, and from that time Bichat was connected with him in his labours and in his fame.

Such is the origin of the reputation of our literary companion, an origin doubly honourable, since it is equally supported by the merit of the pupil and the justice of the master.

Bichat could not long enjoy the benevolent friendship of Desault; death removed this great man in 1795, and left his pupil to regret the loss of an adopted father, and at the same time the honourable task of fulfilling his intentions by the publication of his accumulated materials in his Journal of Surgery.

For a long time Desault had formed the design of arranging, in methodical order, all the discoveries with which he had enriched surgery; he wished to new-model his journal, by retrenching all insulated facts, preserving those whose assemblage might furnish some general inductions; in a word, he was desirous of creating a code of surgical principles or theory. Associated with him in this enterprise, Bichat accomplished, in this circumstance, the difficult office of giving the ideas of his master, and we may well be astonished at what

he dared to undertake at this epoch. He devoted himself with inexpressible ardour to the labours of teaching, prepared his own lectures, directed the anatomical studies of a hundred pupils, and published at the same time the surgical works of his master.

All these occupations never estranged him from his friends; he felt on the contrary the greater need of relaxing with them from the fatigues of a life thus active; and to this necessity we may refer the origin of the Medical Society. At this time arose the noble project, among some pupils of the School of Medicine, of uniting, of communicating the fruit of its researches, of rendering more obvious by discussion, whatever might seem difficult in the lectures of professors, and of repeating experiments, already essayed by the most intelligent physiologists. This plan, being as promptly executed as conceived, had few more zealous partizans than Bichat, and to him the Medical Society of Emulation owes the dijesting of those rules, which for so long a time constituted its glory, and that astonishing impulse, impressed on the minds of all the members who composed it in its early periods.

The Medical Society may, with some reason, boast of having been the first depository of the toils and results which have immortalized our literary brother. In the acts of our Society are found his first views of the membranes, and the discrimination of two species of life; here Bichat began to evince that his genius would overleap the bounds, which it is often so difficult for others to reach. I will not detain you with the modifications which he applied to perfect the trepan, nor with the new method he invented for the ligature of polypi; he attached little importance to these objects; all his attention was devoted to physiology; and his memoir on the Synovial Membrane of the joints, a masterpiece of logic, precision, and of analytical method, gave a just measure of all that Bichat was capable of undertaking.

Our fellow-labourer, professor Pinel, had considered the phlegmatiae in a manner before unknown to the authors of nosological systems.

Attention to the morbid phenomena led him to class these phlegmatiae according to the characters of the organic affections. He supposed, these affections being varied, that the structure of the membranous parts was not the same. Bichat confirmed, in his *Dissertation on the Membranes*, the views and observation of Pinel; and here we ought to admire the mutual concurrence of anatomy and medicine; the latter finds at the bedside of the sick what the former confirms from examination of the dead body; what anatomy calls most conjectural, precedes as it were the certainty, which medicine throws on this beautiful theory of the inflammations. We must acknowledge it, gentlemen, there is greater merit in inferring, according to the diversity of our diseases, the difference in the organization of our parts, than there is difficulty in classing our diseases from a perfect knowledge of these same parts; thus science will be more indebted, in this circumstance, to the first observation of Pinel, than to the anatomical researches of Bichat. The essay on the membranes, which he inserted in the second volume of our acts, was but the summary of a large work, which he soon published on the same subject.

He did not attempt this till after multiplying on himself experiments often dangerous, after opening many dead bodies, and after devoting himself to an attentive observance of morbid phenomena. At this time, after embracing the art in its entire extent, he began to devote his whole mind to medicine; he felt that surgery, illustrated by the surgeons of the last century, would no longer offer him a field sufficiently vast; medicine on the contrary more cultivated since the positive sciences had become more general, especially since the epoch, when for the first time in France professor Corvisart had founded his clinical school; medicine, I repeat, presented to the imagination of Bichat, always ardent, a new aliment, to his genius, new means of distinction.

The Treatise on the Membranes fixed on our colleague the eyes of all the learned; nothing had been seen since the

Treatises on the Glands and on the Mucous Tissue, by Bordue, which could be compared with this work; and the admiration with which it inspired his fellow-labourers, as well as his pupils, penetrated even to the national Institute.* It is in his Treatise on the Membranes that the first glimpse of all those facts which in the end he has developed in his Physiological Researches on Life and Death, and also in his general Anatomy is found; in this work essentially exist the first traces of the method which he followed in all the rest, and here we find reproduced the first ideas which led him to distinguish two sorts of life; a distinction which he had already intimated in a particular Memoir on the symmetrical Organs. At this time appeared a bitter and violent critic of the most astonishing production which perhaps has ever been written in medicine, by a man of twenty seven years. Bichat in this case affected neither resentment nor contempt; he complained without severity of the bad faith and gall of the critic,† and forgot in study this injustice.

He however meditated an answer worthy of himself, and of the science; he believed that in the present state of physiology, the experimental method of Haller, and the grand and philosophical views of Bordeu, were the only guides to consult; he followed these models, and published his Researches on Life and Death. The Medical Society may also claim a sort of right of property in this work.

* On this subject, we know, that in a verbal report, made to the class of Physical Sciences, professor Hallé ranked this work among those which merited the honours of the proclamation at the festival of the 23d of September.

† "I have not attempted to dissipate certain doubts advanced on some anatomical facts, published in my *Treatise on the Membranes*. I refer to the inspection of dead bodies those persons in whom these doubts have arisen; as to those who have started them, this inspection would be useless; they cannot have forgotten that I dissected with them, and that I showed them what they reproach me with having thought to discover, and to have established on conjecture." *Phys. Researches, &c. by Bichat, preface, p. 3.*

In effect Bichat had, in his Memoir on the symmetrical Organs, second volume of our acts, established the distinction of the two lives, animal and organic, a distinction which from that time opened to him a new route, and irrevocably fixed his ideas on the nature of the phenomena of living man. This ray of light struck all the physiologists; some thought they found in Buffon, Bordeu, and Grimaud, similar ideas; others openly reproached with him having borrowed them of these, and finally when the Researches on Life and Death appeared, the envious, condemning themselves to silence, had but the sad resource, in admitting his principles, to refuse to him this discovery.

Thus always above intrigue, he ever controlled it, by opposing to its clamours or its secret arts, the candour of true merit, and the noble perseverance of a man it could not disturb. In the midst of all his labours Bichat did not neglect his favourite occupation, teaching; his school, every day more numerous, formed pupils who spread his doctrines, repeated his precepts, and established, on the most solid foundations, the gratitude, and esteem, and the reputation of their young instructer.

Bichat merited this reward; it was always to him the source of the most delightful feelings; and it is honourable to his heart to confess, that it greatly contributed to support his zeal in his repulsive pursuits. His lectures were not a mechanical occupation in which the professor hastens to acquit himself of his engagements toward his students; nor were they an unproductive pastime, a periodical and fastidious conversation; they presented, on the contrary, the image of a mutual intercourse of enlightened friendship, of a friendship which seeks improvement; can we be surprised that they had charms for him, or that they furnished the means of his immortal work, the general Anatomy? Hitherto anatomy, beset with scolastic minutiæ, too often disgusted by its dryness those young men, who were destined to study the healing art. At this day we cannot recall, without painful impressions, all those multi-

plied divisions, fatiguing descriptions, and that studied prepared language often unintelligible, which formerly constituted the science of anatomy.

Bichat first broke through the common rotine; he exhibited anatomy under a new point of view, studied the general organization of man in the simple tissues, which compose it, dividing the living economy into several *systems;* and in following up these facts, in connecting observation with experiment, he enlarged the boundaries of the science, and has raised to himself a monument, which renders his name imperishable.

It is difficult in reading this work, not to find in every page the traces of that genius, which animated each of his productions; replete with useful applications, elevated views, and points of practice discussed with all the maturity of age; lastly, with perceptions, which in the end were to become fundamental truths.

Bichat composed and published his general Anatomy, in the space of one year; during the night he committed to paper the facts he has left us. Can it be credited that he never copied a second time what was to be printed the next day? Above all, can any one believe, that the two last volumes were completed before the two first? Every thing with him was extraordinary: and certainly this sort of abuse of natural facility evinced at the same time an ardent imagination, which could not be restrained by any rules, and a superior genius, before which a plan once sketched, unfolds itself without omitting the smallest detail.

The general Anatomy was hardly published, when he brought forward two volumes of descriptive Anatomy: rich in facts, free from the useless parade of divisions and subdivisions, this work offers an exact and precise description of the exterior aspect of the organs, of considerations extended over the particular tissues which constitute them, and of numerous researches on the properties of each of them.

The prodigious number of dead bodies he examined to

form this work, the multiplied experiments he performed on living animals, in order to observe nature more minutely, in her sufferings, disorganizations, and her crises, gave him the idea of teaching pathological anatomy.

Always himself, always superior to obstacles, he saw in one fact the germ of a thousand realities, and the instant he seemed engaged in the investigation of what he meditated, was that in which his attention was fixed on the consequences of what he had discovered, and on a thousand accessory objects.

Thus in him one enterprise called up another, and every thing in his principles, bears the impress of that succession of studies, and of that chain of ideas, which suppose a strong and sublimely organized intellect.

A circumstance infinitely auspicious favoured the project he had formed of giving a course of pathological anatomy. Appointed physician of the Hôtel-Dieu, he found in this immense hospital all the facilities which the activity of his imagination could desire; the benevolence of his colleagues, the obliging ardour of his fellow-labourers, and a great number of sick. All these means by redoubling his zeal, cherished in him the necessity of making every thing conspire to his instruction and the increase of science. We know that he desired as a favour to be charged with the business of other physicians, that every day he sought in the cold remains and decompositions of man the causes of the disease, whose fatal effects he had not been able to check; that he acknowledged with candour the errors he might commit, and that, in the multitude of facts he witnessed, he let no one escape, whose relations and consequences he had not studied and foreseen. This investigation, quite capable no doubt of satisfying the mind, did not sooth his heart. It is indeed but little for a soul of sensibility to perceive and estimate the ravages of numberless diseases; it is at least necessary that it be consoled by the possibility of relief in our sufferings. Always placed between death and disease, Bichat would naturally seek to avert

the approach of the former and to mitigate the attacks of the latter. He hoped to find these means in the materia medica; and as the best mode for him to learn was to teach, he began a course of lectures on the materia medica, in which he laid open the finest views, the most fruitful ideas, and the most solid precepts. Who can calculate how far our literary guide and companion would have extended his researches, who can foresee what would have been the term of his glory, if death had not arrested the progress of an existence, to which the remembrance of all the amiable virtues will ever be attached, and of a modesty, which in him was identified with merit? Every day offered him new triumphs, every day he extended the bounds of art, and doubtless he would soon have surpassed the celebrated names who preceded him in the career, which he has illuminated in so brilliant a manner. Bichat, devoted to a most fatiguing kind of life, for a long time carried with him the germ of that fatal attack by which he fell.

Forever in his laboratory of anatomy, or in the wards of the Hôtel-Dieu, he inhaled with the atmosphere the elements of an approaching destruction. Engaged on the eighth of July in examining the progress of a putrefaction of the skin, an infectious fœtor rising from the macerating vessel, repelled the pupils, the common companions of his labours; he alone had the temerity to pursue his researches, in a low and humid place. Coming from this laboratory, he fell prostrate; faintings followed; in a few days after, all the symptoms of an ataxic fever appeared. I witnessed the truly maternal solicitude, which the estimable widow of his master lavished upon him; I saw her tender care, and two days before his death, this respectable woman, encouraged by some hopeful symptoms, flattered herself from some deceptive glimmerings, with an approaching convalescence. Her hope vanished the same day; a violent paroxysm destroyed all the tranquillity of our minds, arising from a state somewhat satisfactory, in which we had seen Bichat, who died on the twenty second of July, in the fourteenth day of his disease.

Such was the end of a man, who at the age of thirty one years, had already obtained successes and undertaken labours, which would have immortalized many learned men. Struck down at an age when the fire of imagination, the vivacity of genius, and the activity of the constitution are in all their strength, of what would he not have been capable, when a long experience, the observation of many years, and the maturity of age, would have rectified what he himself could have blamed in his works, or extended still further the sphere, already immense, of the useful discoveries and applications which he had made?

If after having recalled to the society all the titles of Bichat to esteem and the public consideration, we consider the qualities, which made him cherished by all who knew him, we shall more fully feel the extent of the loss we have sustained. He was a good son, a sincere friend, an honest man; his modesty made him less apprehensive for himself, than for his booksellers, of the non-success of his works. He carried this virtue perhaps even to timidity. His character always equal, always frank, always generous, bore without impatience, injustice, and even injury. He was never seen meanly to solicit praise, to desire places, or to accumulate titles; he was ignorant of that shameful commerce of the reputations of journals, that sort of literary brokerage, in which eulogies seem to be a usurious restitution of those which one of the contracting parties has previously received. He was a stranger to those little passions, of which he was sometimes the victim; his unutterable sweetness of disposition, the candour of his soul, would often attempt to excuse the injuries of those who envied him. He maintained in the habitual commerce of life a gentleness, and a goodness, which invariably attached to him many of us. He had also among the most distinguished persons of our art, zealous admirers, sincere friends. To describe them here is to honour his memory; and the affectionate esteem which Messrs. Corvisart, Lepreux, Hallé, Thouret, Pinel, and Leroux bore him, is without contradiction a proof of the superior merit of our scientific friend.

The first has just employed the influence which his eminent station gives him, to call the attention of government to the recompense which he merited. Friendship, in this instance, showed itself doubly attentive, since it has obtained for the master and pupil equal honour, by a monument which, in approximating their names, would transmit them together to posterity.

We too, we can raise to the memory of our colleague a monument, which shall perpetuate among ourselves even the remembrance of his features. M. Giraud, in the midst of the tears which the death of his friend wrung from him, took care to preserve the print of the figure of Bichat. If among the learned societies to which he belonged there is one which should hasten to place his bust in the place of its sittings, it is this, without contradiction, which he may be said to have founded; whose regulations he digested, and to which he has done the homage of his first works.

I desire that the society may subscribe for one of the busts of Bichat, and that it may be placed in this hall, as a monument of the esteem which the society bore him, and as a pledge of union which should animate all the members which compose it.

The Medical Society voted in its session extraordinary of the third of September, that the bust of M. Fr. Xav. Bichat should be placed in the ordinary place of its sessions.

A

TREATISE

ON THE

MEMBRANES IN GENARAL.

ARTICLE FIRST.

GENERAL CONSIDERATIONS ON THE CLASSIFICATION OF THE MEMBRANES.

1. The membranes have not hitherto been a particular object of research among anatomists. This kind of organs, disseminated as it were through all the others, contributing to the structure of most of them, and having rarely a separate existence, have never been separately examined by them.

Their history has been associated with that of the organs over which they are spread. The pericardium and the heart, the pleura and the lungs, the peritoneum and the gastric organs, the sclerotica and the eye, the glans penis and its mucous envelope, the intestines and their spongy tunics, in their works, always pertain to the same chapter. For description, this is doubtless the best and most simple progress; but in following it, anatomists, struck with the different structure of the organs, have forgotten that their respective membranes could possess any analogy; they have neglected to establish any relation between them, and this leaves an essential chasm.

2. Science requires, in our anatomical books, some general considerations like these, to precede the treatise of each organic system, such as the nervous, vascular, muscular, bony, ligamentary, and others; considerations, which form the most beautiful part of the study of the animal structure, and which exhibit nature every where uniform in her operations, varying only in their results, sparing of the means she employs, prodigal only in the effects she obtains; modifying in a thousand ways a few general principles which, differently applied, preside over our economy, and constitute its numberless phenomena.

3. Haller, who, under the triple relation of erudition, experiments, and observation, seems to have exhausted every other point as it were of anatomy, has but touched on this.

In his article on the membranes in general, he does not establish among them any line of separation. A similar texture confounds them all; to his view they are but a modification of the cellular organ which furnishes their common basis, always easily reduced to its primitive state.

This opinion, true in one respect, will be proved evidently false in others, in the course of this work. The slightest reflection makes it easy to conceive that these organs must differ, not only by the different arrangement of the interwoven fibre which forms them, but also by the nature of this fibre itself; there is between them a difference of composition as well as of tissue.

Can this composition be the same in parts distinct

in their external conformation, their vital properties, and their functions ?

4. Several celebrated physicians have perceived this fact since Haller ; they have been sensible that in the system of the membranes, different limits were to be settled between organs hitherto confounded.

From observing the marks of inflammation to be extremely varied in each membrane, they were convinced of the necessity of this distinction.

For often the morbid, more than the sound state, clearly develops the difference of the organs among themselves, because in the former rather than the latter, the vital energy is clearly manifested.

M. Pinel has established, according to these principles, a judicious affinity between the different structure and the different diseases of the membranes ; it was in reading his work that I first received this idea, though many results appear here, as will be seen, very different from those he has announced.

5. When we embrace in one general view all the membranes of the organic economy, it seems their classification should be very complicated, as well in regard to their astonishing multiplicity, as on account of their apparent variety in each region.

It is not exaggerating the proportion of internal membranes with the skin, to fix it from 8 : 1 ; and if it were possible to collect them all on a single surface, perhaps no one would present an aspect exactly similar to that of another. Yet however little we reflect on their structure and their functions, we soon see that many approximate, and though a different external

conformation seems to distinguish them, yet this difference is merely in the form and not at all in the basis of their organization.

6. It is therefore necessary, precisely to determine what membranes belong to the same class; which those are that differ or approximate among them: yet let us observe here, that the characters of our divisions should not be founded on exterior attributes, foreign as it were from the nature of the organ, but in this nature itself.

It is only on the simultaneous identity of exterior conformation, of structure, of vital properties and functions, that two membranes should be classed together. Let us leave to other sciences the artificial methods of distribution; it is only by natural methods that we can here be led to useful results.

7. In thus classing the membranes we may, I believe, refer them to two general divisions, simple and compound. I call those, simple membranes, which are not connected by any direct relations of organization, with the parts contiguous; a compound membrane is formed of two or three of the preceding, and often unites characters very dissimilar.

8. We may distribute the simple membranes into three general classes; the first comprises the *mucous* membranes, so named from the fluid which habitually moistens their unconnected surface, and which is furnished by the small glands inherent in their structure. They line all the hollow organs which communicate exteriorly by different openings through the skin; such are the cavities of the mouth, the oesophagus, the

stomach, the intestines, the bladder, the womb, the nasal fossæ, all the excretory ducts, etc. In the second class are found the *serous* membranes, also characterized by the lymphatic fluid, which incessantly lubricates them, and which, being separated from the mass of blood by exhalation, differs in this from the preceding fluid, which escapes from the blood by secretion.

Here belong the pericardium, pleura, peritoneum, the tunica vaginalis, the arachnoides, the synovial membrane of the joints, that of the groove of the tendons, etc.

The third and last class comprehends the *fibrous* membranes; these, not moistened by any fluid, are thus named from their texture, composed of a white fibre, analogous to that of the tendons, and to which are referred the periosteum, the duramater, the sclerotica, the envelope of the corpora cavernosa, the aponeuroses, the articular capsules, the tendinous sheaths, etc.

I offer none of the characters of these membranes, to support this division; their description will serve to establish all their differences, and thus prove the justness of the distinction between them.

9. Each of the preceding simple membranes concurs, in different parts, to form the compound membranes, which I divide into *fibro-serous*, *sero-mucous*, and *fibro-mucous*.

10. Besides these simple and compound membranes, there are some others, which, either entirely unknown in their organization, or known only as sep-

arate membranes, existing single of their kind, cannot form a part of any classification.

11. Finally, the membranes accidentally developed in the morbid state, such as the pellicle of cicatrices, the membranous sack formed by cysts, etc., deserve also attention, both on their own account, as well as from their analogy to the natural membranes.

ARTICLE II.

OF THE MUCOUS MEMBRANES.

§ 1. *Of the extent and number of the mucous membranes.*

12. The mucous membranes, as we have said, occupy the inside of the cavities communicating with the skin by its different openings. Their number, at first sight, is very considerable, because the organs, within which they are reflected, are greatly multiplied.

The stomach, the bladder, the urethra, the womb, the ureters, the intestines, etc. etc. borrow each from these membranes, a part of their structure; yet if we consider, that these are every where continuous, that in their elongations they always arise from one another, as they primarily arise from the skin; we shall perceive that this number must be particularly limited.

In thus considering them, not singly in each part, but at the same time in all those where they are continued, we see they are reduced to two general surfaces, of which all the others are portions.

13. The first of these surfaces penetrating through the mouth, the nose, and anterior surface of the eye,

1. lines the first and second of these cavities, extends from the former into the excretory ducts of the parotids, and of the submaxillary glands; from the latter, into all the sinuses, forms the conjunctiva, passes into the lachrymal points, the canal, the nasal sack, and into the nose; 2. descends into the pharynx, and there furnishes a process to the Eustachian tube, then penetrates to the internal ear, and lines it as we shall see; 3. dips into the trachea, and is spread over all the air passages; 4. penetrates into the œsophagus and stomach; 5. extends into the duodenum, where it furnishes two elongations, destined, one to the ductus choledochus, to the numerous branches of the hepatic, the cystic, and to the gall bladder; the other to the pancreatic duct and its numerous branches; 6. is continued into the small and large intestines, and terminates at last in the anus, where it is lost in the skin.

14. The second general mucous membrane penetrates in man through the urethra, and thence spreads, on the one hand, over the bladder, the ureters, pelvis, and mammillary processes of the kidney and the capillary canals which open at their summits; on the other, it enters the excretory tubes of the prostrate gland, into the ejecting ducts, the seminal vesicles, the vasa deferentia, and the thousand folds of the branches which give them birth. In women this membrane is introduced through the vulva, and penetrating on one side through the urethra, is carried as in men, over the urinary organs; on the other we see it enter the vagina, line it, as well as the womb, the Fallopian tubes, and then to be continued with the poritoneum through the openings of these ducts.

This is the only example of a communication between mucous and serous surfaces.

15. This manner of pointing out the passing of the mucous surfaces, in saying they extend, sink, penetrate, etc. from one cavity to another, is doubtless not conformable to the progress of nature, which creates in each organ the membranes which pertain to it, and does not thus extend them from step to step; but our manner of conception agrees better with this language, whose import the smallest reflection will correct.

16. In thus referring to two general membranes, all the mucous surfaces, I am not only supported by anatomical inspection, but pathological observation furnishes me both with points of distinction between the two, and points of contact between the different portions of membranes, of which each is the assemblage.

In the different descriptions of catarrhal epidemics, given by authors, we frequently see one of these membranes affected through its whole extent, while the other remains untouched; it is not uncommon especially to observe a general affection of the first, of that passing from the mouth, from the nose, and the surface of the eye into the alimentary passages and bronchia. The last epidemic observed at Paris, with which M. Pinel was himself affected, bore this character; that of 1761, described by Razous, was the same; that of 1732, described in the Memoirs of the Society of Edinburgh, was remarkable for a similar phenomenon: now we do not see a corresponding

disease in the mucous membrane which is spread over the urinary and generative organs. There is here then, 1. an analogy between the portions of the first, by the uniformity of disease; 2. a demarcation between the two, by the soundness of the one and the disease of the other.

17. We also find that the irritation of some one point of one of these membranes, frequently produces pain in some other point of the same membrane, which is not irritated. Thus the calculus in the bladder causes a pain in the glans; the presence of worms in the intestines, an itching of the nose, etc. etc. Now, in these purely sympathetic phenomena, it is extremely rare, that the partial irritation of one of these two membranes should painfully affect one of the parts of the other.

18. We should then, in conformity to inspection and observation, consider the mucous surface in general, as formed by two great membranes, successively spread over many organs, having no communication except by the skin, which serves them as an intermedium, and which continuing with both, thus concurs with them to form one general membrane, every where continuous, covering the outside of the animal, and extending within over most of its essential parts. We conceive, that important relations must exist between the inner and outer portions of this single membrane: this will soon appear from further researches.

§ 2. *The exterior organization of the mucous membranes.*

19. Every mucous membrane presents two sur-

faces, one adhering to the neighbouring organs, the other free, rough with villosities, and always humid with a mucous fluid.

Each deserves particular attention.

20. Almost every where the adhering surface corresponds to muscles. The mouth, the pharynx, all the alimentary canal, the bladder, the vagina, the matrix, a portion of the urethra, etc., present a muscular lamina embracing exteriorly their mucous tunic, which is on the inside.

This disposition coincides perfectly in animals having a fleshy membrane, with that of the skin, which besides approaches so nearly to the structure of the mucous membranes, as we shall see, and which, as we have seen, is every where continuous with them.

In man also, the cutaneous organ presents here and there some traces of this exterior muscle, as we remark in the platysma myoides, palmaris longus & brevis, in the occipito-frontales, in most of the musiles, etc. etc. This disposition of the mucous membranes, produces the habitual motions of contraction and dilatation which favour the secretion they carry on, and the various other functions, of which they are the seat.

21. The insertion of this muscular layer is not immediately into the outer face of the mucous membranes, but according to Albinus, into a dense lamina of the cellular tissue, which all the older authors have described, in the stomach, bladder, intestines, etc., under the name of the nervous coat; but which, carefully examined, exhibits no character similar to that which the name imports.

The experiment of inflation by which it is reduced to its primitive state, is not so easy as Albinus and others have pretended; this has led me to suspect, that the nature of this muscular stratum might not be cellular, that it was probably of a fibrous texture, formed by the assemblage and interlacing of numberless tendons, extremely slender and hardly perceptible, presenting points of origin and termination to all the fleshy fibres of the muscular layer, which, as we know, never describe entire circles, but segments of a circle, more or less extensive. I acknowledge that this suspicion, though sufficiently probable, is not founded on any decisive, rigorous experiment.

22. Whatever be the nature of this membrane interposed between the mucous and the muscular, in other respects, it has evidently a dense, close texture, which gives to it a resistance very analogous to one of the fibrous laminæ. From this the organ receives its form; this maintains and supports the form, as the following experiment proves. Take a portion of intestine; remove any part of this layer, as well as the serous and the mucous layers, then inflate it, after tying it below: the air produces in this place a hernia of the mucous coat. Then turn up another portion of intestine; remove from it a piece of its mucous membrane, and from this, inflation will produce in the serous and muscular coats, the same phenomenon it raised before in the mucous; it is then to this intermediate layer that it owes its resistance to the substances tending to it. We can say the same of the stomach, bladder, the œsophagus, etc.

23. The free surface of the mucous membranes, constantly wet with the fluid whence they borrow their names, presents two species of folds or wrinkles.

The former adhering to the structure of these membranes, always meet there, whatever may be the state of delatation or contraction of the organ; such are the polypus, the valvulæ conniventes of the small intestines, that of Bauhin, etc. These plaits or folds are formed, not only by the mucous membrane, but also by the intermediate tunic of which we have spoken, which here takes a remarkable density and thickness, securing their solidity.

24. The other folds are, as it were, accidental, and are only observed during the contraction of the organ; like those of the inside of the stomach, the large intestines, etc.

In most of the human dead bodies, brought to our amphitheatres, these folds, of which so much is said of those in the stomach, are not there capable of being seen, because most commonly the subject has died after disease has altered its vital power, so as to hinder all actions of this viscus; and thus, though often found empty, its fibres are in no degree contracted.

25. In experiments on living animals, on the contrary, these folds become very perceptible, and may be demonstrated.

Let a dog eat or drink copiously, open him instantly, and divide the stomach along the great curvature; no fold is then apparent, but soon it contracts; its edges are turned over, and all the mucous surface is covered with an infinitude of prominent folds, in form of circumvolutions.

We obtain the same result in tearing the stomach from an animal recently killed; distending it with air, and then opening it, or by splitting it immediately in its empty state, and in pulling it in different directions by its edges; it is stretched, these plicæ disappear, and if we cease to extend it, they are readily formed again in a visible manner.

26. I observe, on the inflation of the stomach, that in distending it with oxygen, we do not produce by the contact of this gas, more prominent wrinkles, and consequently a stronger contraction, than in making use of the carbonic acid gas for the same purpose. This experiment presents a result very similar to that I have observed in rendering animals emphysematous by different aëriform fluids. Frogs and Guinea pigs (these were the animals chosen for an example of red cold blood, and of red warm blood) present but very little difference in their irritability, and in their galvanic susceptibility, whether they be inflated by oxygen, or filled with carbonic acid gas, and that consequently their muscles have been in contact with one or with the other, a result different from that of various asphyxiæ. They live very well with this artificial emphysema, which is gradually dissipated. The emphysema with the nitrous gas is constantly fatal, and its contact seems to strike the muscles with atony. Distended with this gas, the stomach, after a short time, no longer contracts, and its folds no longer appear.

In other respects, here, as in all experiments relating to the vital forces, we obtain results often very variable.

27. It follows from what we have said on the folds of the mucous membranes, that in the contraction of the hollow organs which these membranes line, they sustain but a very slight diminution of surface, that they scarcely contract at all, but are plaited on the inside, so that dissecting them in this organ when contracted, they are almost as extensive as in its dilatation. This assertion, true as to the stomach, the œsophagus, and intestines, is not quite so much so in respect to the bladder, which, when contracted, exhibits on the inside these folds less perceptible; but they are enough so not to deviate entirely from the general law.

It is nearly the same in the vesicula fellis, though here we find another cause.

Alternately observed in hunger and during digestion, the gall bladder contains double the bile in the former case that it does in the latter, as I have a thousand times noticed. When the vesicula is partly empty, it does not contract on the remaining bile, with the energy of the stomach when it contains but little food, or with the force of the bladder when it retains but little urine.

It is then flabby, so that its distention or non-distention has but little influence on the plaits of its mucous membrane.

28. In saying that the mucous membranes always present nearly the same surface in the distention and contraction of their respective organs, I mean to speak only of the ordinary state of the functions, and not of those enormous dilatations of which we often see the stomach, the bladder, and more rarely the intestines, become the seat.

There is however a real extension and contraction, which, in the membrane, coincide with those of the organ.

29. A remarkable observation, which the polished surface of the mucous membranes presents us, is, that this surface is every where in contact with bodies heterogeneous to that of the animal, whether these bodies introduced from without for nourishment and not yet assimilated to its substance, as we see in the alimentary canal, and in the trachia; or are supplied from within, as we see in the excretory ducts of the glands, which all open into cavities lined with the mucous membranes, and transmit exteriorly the molecules, which, after having, for some time, contributed to the composition of the solids, become heterogeneous to them, and are separated from them by the habitual progress of decomposition, which is carried on in living bodies.

Agreeably to this observation, we should regard the mucous membranes as barriers, which, placed between our organs and the substances which are foreign to them, should guard them against the fatal impression of these substances, and consequently contribute within to the same functions which the skin performs on the exterior, with regard to bodies which surround that of the animal, and which incessantly tend to act upon it.

§ 3. *Interior organization of the mucous membranes.*

30. There is between the mucous and other membranes, this essential difference with regard to the inte-

rior organization, that these always originate from the assemblage of several layers, the serous, fibrous, etc., having never but one. These laminæ or layers are, with the exception of the corpus reticulare, the same as those which compose the skin, with which these membranes have the most exact analogy.

We shall examine each of these layers separately, the epidermis, the corpus papillare and the corion, in their general attributes. We will then consider the particular modifications which they undergo in the different parts of the mucous surfaces.

31. All authors have admitted the epidermis of the mucous membranes; it seems indeed that most have believed that this portion of the skin is all that descends to line the cavities. Haller, in particular, is of this opinion. But the least inspection is sufficient to occasion the remark here, as in the skin, that it merely forms a superficial layer to the corpus papillare and to the corion. Boiling water, which detaches it from the palate, the tongue, and even the pharynx, then leaves the other two layers exposed to view.

32. This epidermis is very distinct on the glans, at the entrance of the anus, of the urethra, of the nasal fossæ, of the mouth, and in general wherever the mucous membranes begin to be separated from the skin.

It is demonstrated in these different places by the frequent excoriations which take place in them, in the lips especially, when raised by a very fine lancet, by the action of boiling water, the approach of a red hot iron, and even by blisters, as is proved by the method of the ancients, who to repair the loose edges of the hair-lip, employed this process.

33. But as we descend into the depth of the mucous membrane, it is the more difficult to ascertain the existence of this tegument. The most delicate instrument cannot raise it. Boiling water does not separate it, at least in the intestines, the gall-bladder, and the stomach, which I have subjected to this experiment, both when the vital heat had abandoned them, and when they were torn palpitating from the living animal, they were still fully penetrated with the powers of life.

But what our experiments cannot do, inflammation frequently accomplishes. All the authors, who have written on the diseases of the organs which these membranes line, cite examples of shreds, more or less considerable, rejected from the urethra, the anus, the mouth, the nostrils, etc. Haller has collected a great number of similar observations. Without doubt the separation of the epidermis then takes place nearly, as we see, in cutaneous inflammations. In several bodies, which have died with signs of inflammation of the mucous membranes, and which I have dissected, I have not yet been able to see this separation going on, that is, the epidermis rising in one point and adhering in others, as in erysipelas. I have unsuccessfully attempted to do it by the application of an epispastic, on the internal tunic of the intestines of a dog.

34. This epidermis, like that of the skin, is subject to become callous by pressure. Choppart cites the example of a shepherd, whose urethra presented this disposition, after the repeated introduction of a little twig, to procure voluptuous enjoyment. We know

what thickness this covering assumes in the stomach of the gallinacea.

In certain circumstances, where the mucous membranes pass out of the body, as in prolapsions of the anus, vagina, uterus, in imperforated anuses, etc., sometimes the pressure of the clothes produces a sensible thickening of this epidermis.

35. The epidermis is joined to the hairs on the skin, though it does not immediately give them origin. Sometimes also piliform productions are observed in the mucous membranes. The bladder, stomach, intestines, and the pituitary membrane have been, in different circumstances, the seat of these unnatural excressences. Haller has many examples of them.

36. This covering seems to possess the same texture in the mucous membranes as in the skin, excepting the fineness of the laminæ of which it is composed.

It is to this fineness, and even to the denudation of the nerves, that we must refer the facility of exciting various remarkable modifications in the sensibility, when by means of galvanism, we place a piece of zinc on the tongue, and some other metal on the mucous surface of the conjunctiva, of the pituitary membrane, of the inner membrane of the rectum, or of the gums, etc., and bring these different metals into mediate or immediate contact. The epidermis is readily reproduced. Destitute of sensibility, it is destined, like the skin, to defend the very sensible corpus papillare which lies subjacent.

To its presence over the mucous membranes we are to attribute their capacity of being exposed to the

air and even to the contact of external substances, without expoliating or inflaming, as we see in imperforated anuses, prolapsus ani, etc., while the fibrous and serous membranes can never bear this contact with impunity: hence there is no danger, at least in this respect, in opening the bladder; hence on the contrary the precept, so justly recommended, not to open the cavity of the peritoneum, to cut the synovial capsules as little as possible, etc. It is important to consider the existence of the epidermis on the mucous membranes, on account of the opinion of those who, like Seguin, believing them deprived of it, have said that contagion is always taken by the lungs, and not by the skin, which according to them is protected by this covering.

37. To the epidermis succeeds in the organization of the skin, the corpus mucosum or reticulare, specially described by Malpighi, and generally considered as the seat of colour in the different tribes of men. It is described as a layer, pierced with holes for the passage of the nervous papillæ.

M. Sabatier points out the manner of seeing it; it is said Sœmmerring has separated it from the epidermis and the corion in the scrotum of an Ethiopean. I confess I have not yet been able to discover it, and M. Portal seems not to have been more fortunate.

38. A sort of gelatinous juice merely is distinguished between the corpus papillare and epidermis, and more commonly even this is not visible; I have never been able to observe it with precision. In a careful examination of the skin of a negro, the epidermis

being raised, I saw the external surface of the corion died black, and that was all.

Further, whatever this reticular body and this mucous coating may be, they certainly do not exist in the mucous membranes, since they have no share in colouring the integuments. The heat of the sun which tans these in white people, does not seem to act on the beginning of these membranes, equally exposed to this heat, as we see at the red edge of the lips, etc. I have however several times remarked, in the palate of dogs subjected to my experiments, certain stains analogous to those which here and there colour their outer covering.

39. The sensibility of the skin, we know, is principally owing to the papillary body; that of the mucous membranes, entirely similar to that of the skin, seems to originate from the same cause. The papillæ of these membranes, cannot be doubted at their origin; where they sink into the cavities, at the commencement even of these cavities, as on the tongue, the palate, at the internal part of the alæ nasi, on the glans, in the fossa navicularis, inside the lips, etc. Inspection is sufficient to demonstrate them in these places. But it is asked whether these papillæ exist likewise, in the deeper recesses of these membranes.

Analogy implies it, since the sensibility is the same here as at their origin; but inspection proves it in a manner no less certain. I believe that the villosities, with which we see them every where beset, are no other than these papillæ.

40. Very different ideas have been entertained on

the nature of these villosities; they have been considered in the œsophagus and stomach, as intended for the exhalation of the gastric juice, in the intestines for the absorption of the chyle, etc.

But, 1. it is difficult to conceive how an organ, every where nearly the same, should accomplish, in different parts, functions so different. I say nearly the same, for we know the villi of the small intestines are more prominent than those of the large, etc. 2. What would be the functions of the villosities of the pituitary membrane, of the internal coat of the urethra, and of the bladder, if they have no relation to the sensibility of these membranes? 3. The microscopical experiments, so much vaunted by Leiberkhun, on the swelling of the intestinal villosities, are contradicted by those of Hunter, of Cruikshank, and especially by those of Hewson.

I can assert that I have never seen any thing of the kind on the surface of the small intestines, at the instant of chylous absorption, and yet it seems a matter of inspection cannot vary. 4. It is true that these intestinal villosities are every where accompanied by a vascular network, which gives them a red colour very different from the colour of the cutaneous papillæ; but the nonappearance of the cutaneous network arises from the pressure of the atmospheric air, and especially from the crispation which it occasions in the small vessels. See the fœtus just appearing from its mother's womb, its cutaneous surface is then as red as that of its mucous membranes; and if the papillæ were a little more extended, its skin would exactly re-

semble the internal surface of the intestines. Beside, who does not know that the vascular plexus, surrounding the papillæ of the skin, is made perceptible by fine injections, so as to change entirely the colour of the skin?

41. That in the stomach, this vascular network exhales the gastric juice; that in the intestines, it is interwoven with the origin of the absorbents, in such a manner that the latter embrace the villosities, is what no one can doubt, after the experiments and observations of those anatomists who have latterly investigated the lymphatic system.

The basis however of these villosities may still be nervous, and they may perform in the mucous membranes the same functions which the papillæ perform in the cutaneous organ. This method of considering them in explaining their existence, generally observed on all the mucous surfaces, seems to me much more conformable to the plan of nature, than to suppose them in each place to execute different and even opposite functions.

42. It is difficult to decide the question by occular observation. The tenuity of these elongations conceals their structure, even from our microscopic instruments, a species of agents from which physiology and anatomy, do not seem to me, besides ever to have derived any great assistance, because when we view an object obscurely, every one sees in his own way, and according as he is affected. The observation of the vital properties ought then above every thing to guide us: now it is evident, that in judging

according to these, the villosities possess the nature which I attribute to them. The following experiment enabled me to demonstrate the influence of the corpus papillare over the sensibility of the skin; it also succeeded in the mucous membranes. Raise the epidermis, and irritate the corpus papillare with a sharp probe; the animal starts, cries, and gives signs of severe pain. Then slip through a small opening, made through the skin, a pointed probe into the cellular tissue under the cutis, and irritate the internal surface of the corion; the animal remains quiet, makes no complaint, unless some filaments of nerve, hit by chance, produce the suffering.

It follows clearly from this, that the sensibility of the skin resides on its external surface, that the nerves traverse the corion, without contributing to its texture, and that their expansion takes place only in the corpus papillare. It is the same in the mucous surfaces.

43. The length of the papillæ, and even their form, vary in the different mucous surfaces; their aspect is not the same in the stomach, the intestines, the bladder, the viscula fellis, on the glans, etc.; which coincides very well with the sensibility proper to each organ, a sensibility proved by a multitude of observations collected since Bordeu, who first fixed the attention of physiologists on the particular modifications which this property undergoes in different parts.

44. The mucous membranes have their corion as well as the skin; it is thick in the palate, the gums, and pituitary membrane; more thin in the stomach and intestines; not distinct in the bladder, gall bladder, nor in the excretory ducts.

It seems to be formed of cellular laminæ condensed, and strongly united, like the skin. Maceration develops this texture very clearly. There is however this difference, that in dropsy, the cutaneous corion is raised and formed into distinct cells filled with water; while nothing similar is observed, in the same circumstance, in the mucous corion.

Does this difference of morbid state suppose a difference in its structure? No; for the synovial membrane is certainly of the same nature as the serous membranes, and yet it does not at all partake of the hydropic diatheses which often affect them altogether.

It would be curious to expose the mucous membranes to the action of tannin, to see if they would exhibit the same phenomena as the skin.

§ 4. *Glands of the mucous membranes.*

45. Beside the triple layer, of which we have just spoken, the mucous membranes present also, in their structure, a very great quantity of glands, and numerous blood vessels.

The mucous glands exist in all the membranes of this name; situated below their corion, or even in its thickness, they incessantly pour forth, through imperceptible holes, a mucilaginous humour, which lubricates their free surface, and protects it from the impressions of bodies, with which it is in contact, at the same time that it favours the movement of these bodies.

46. These glands, very apparent in the bronchia, palate, œsophagus, and in the intestines, where they

take the name of the anatomists who have described them with exactness, are less sensible in the bladder, womb, vesicula fellis, vesiculæ seminales, etc.; but the mucosity, which moistens their membranes, demonstrates their existence.

In effect, since this fluid is, on the one hand, very nearly the same on all the mucous surfaces, and on the other, in those where the glands are apparent, it is evidently furnished by them; it ought to be secreted in the same manner in those where they are less sensible.

The identity of fluids secreted supposes identity of secretory organs. It seems where these glands are concealed from our sight, that nature makes amends for their tenuity by their number. There are some animals in the intestines of which especially, they form by their multitude, a kind of new layer added to those we have just mentioned.

This is remarkable in the human palate, in the columnæ veli, etc.

47. There is then this great difference between the mucous, and the serous membranes, that the fluid which lubricates the former is furnished by secretion, while that, which moistens the latter, is supplied by exhalation. We know little of the composition of the mucous fluids, because in the natural state it is difficult to collect them, and in the morbid state, where their quantity is increased, as in catarrh for instance, this composition is probably changed. But their functions in the animal economy are not doubtful.

48. The first of these functions is, to defend the mucous membranes from the impression of bodies

with which they are in contact, and which, as we have observed, are all heterogenous to that of the animal.

This is doubtless the reason why the mucous fluids are more abundant where these bodies remain some time, as in the bladder, the extremity of the rectum, etc., than where they merely pass, as in the urethra, and generally in all the excretory ducts. Hence also when the impression of these substances might be fatal, these fluids are diffused in greater quantity over their surfaces.

The sound which remains in the urethra, the instrument which is left in the vagina to compress a polypus, that left for the same purpose in the nasal fossæ, the canula fixed in the lachrymal sack to remove an obstruction, that which is tied in the œsophagus to counteract an impeded deglutition, always produce, in the corresponding portions of mucous surface, an augmented flow of the mucous secretion, which is habitually poured out. This is one of the principal reasons why it is difficult to retain elastic sounds in the trachia.

The abundance of mucous then separated, by stopping the holes of the instrument, render necessary its frequent introduction, and sometimes may even threaten the patient with suffocation, as Desault has himself observed, though he has notwithstanding many times derived great advantages from this means.

49. It seems then that any considerable excitation of the mucous surfaces produces in the corresponding glands, a remarkable increase of action.

But how can this excitation, which does not take

place immediately in the gland, have so great an influence over it? For as we have said, these glands are always subjacent to the membrane, and consequently separated by it, from the bodies which irritate it. This seems to arise from a general modification of the glandular sensibility, which is susceptible of being brought into action by any irritation confined to the end of the excretory ducts. The following considerations will serve to prove it. 1. The presence of aliment in the mouth, produces a more abundant flow of saliva. 2. The sound fixed in the bladder, and irritating the ureters or their neighbourhood, augments the efflux of urine. 3. A partial introduction of a bougie into the urethra is often sufficient to make the bladder contract in such a manner as to overcome the obstacles of the canal. 4. The irritation of the glans and of the end of the urethra produces, in coition, the contraction of the vesiculæ seminales, and increases the secreting action of the testicle. 5. The action of a fluid irritating the conjunctiva, occasions an abundant secretion of tears. 6. In experimenting on the state of the gastric viscera during digestion and during hunger, I have observed that, while the food remains in the stomach only, the flowing of the bile is small, but when the aliment passes the duodenum, the bile increases, so that there is much of it at this time in this intestine.

During hunger the gall-bladder is fully distended, but little flows into the intestines. At the end, and even in the middle of digestion, the vesicula contains one half less of bile; yet it should the more easily

empty itself in abstinence, as the bile is then of a deep green, very bitter, and very acrid, and consequently very susceptible of irritating the organ which contains it. On the contrary, in the middle of digestion or immediately after it, it is much more clear, more mild, less irritating; another stimulus then is requisite during digestion; and this stimulus is the aliment passing by the extremity of the ductus choledochus.*

* There has been much controversy to ascertain whether there be a cystic and an hepatic bile; if their nature differed; whether their quantity increased or varied, etc. Opinions contrary and even opposite have been supported from numerous experiments, made on living animals, as Haller has very well observed. These experiments, though at first view contradictory, are in reality not so, as I have had occasion to be convinced, in repeating them at different stages of digestion, and during the abstinence of the animal, which no one had yet done with precision. This is what I have observed on the dogs which have served for my experiments. 1. During abstinence the stomach and small intestines being empty, we find the bile of the ductus hepaticus and choledochus, yellowish, clear; the surface of the duodenum and of the jesunum tinged by a bile of the same aspect; the vesicula fellis very much distended with a greenish bile, bitter, the more deep coloured and more abundant, as the fasting has been longer. 2. During the gastric digestion, which can be prolonged by giving the dog large pieces of meat, which he swallows without chewing, things are nearly in the same state. 3. In the commencement of the intestinal digestion, the bile of the hepatic duct is always yellowish, that of the ductus choledochus is more deeply tinged, the vesicula less full, and its bile becoming more clear. 4 At the end of digestion, and immediately after, the bile of the ductus hepaticus and choledochus, that in the vesicula fellis, that which is spread over the duodenum, are absolutely of the colour of the ordinary hepatic bile, that is, of clear yellow, slightly bitter. The vesicula is but half full; it is flaccid, but not contracted.

These observations, many times repeated, evidently prove, that in this manner the bile flows during abstinence and digestion. 1. It seems at all times that the liver secretes a considerable quantity of this fluid,

50. We conclude from these numerous considerations, that one of the principal means which nature employs to increase the action of the glands and to excite that of the excretory ducts, is the irritation of the extremity of these conduits, and that to this cause we must refer the abundant secretion and excretion of the mucous fluids in the cases above mentioned.

To this irritability of the ducts of the mucous glands, we are also to attribute the artificial rheums which have been produced by breathing the vapours of the oxigenated muriatic acid, the mucous discharge which accompanies a polypus, any tumour in the va-

which is increased during digestion. 2. What is furnished during abstinence is divided between the intestine, which is always coloured with it, and the gall bladder, which retains it, without pouring any portion of it through the cystic duct, where thus retained it acquires a sharpness, and deep colour, necessary to the approaching digestion. 3. When the aliments, digested by the stomach, pass into the duodenum, then all the hepatic bile, which was before divided, flows into the intestine, and even in greater abundance; on the other hand, the gall bladder also pours its contents, over the alimentary pulp, which is then fully penetrated with it. 4. After the intestinal digestion, the hepatic bile diminishes, and begins to flow in part into the duodenum, and to revert in part into the vesicula fellis, where it is then clear and in small quantity, because it has not yet had time, either to acquire colour, or collect in large quantity.

There is then this difference between the two species of bile, that the hepatic flows continually into the intestine, and that the cystic flows back, except in the period of digestion, into the gall bladder, and flows during this function, toward the duodenum; or rather it is always the same fluid, one part of which always preserves the character which it has while passing from the liver; another part assumes a different character in the gall bladder. The diversity of colour of the cystic bile, according to its retention, is analogous to the colour of the urine, which, retained longer or shorter in the bladder, becomes more or less highly tinged.

gina, the stone in the bladder, etc., the frequency of fluor albus in women who make an immoderate use of coition, an increased discharge of mucus from the nose of snuff takers, etc. In all these instances there is obviously an excitement of the ends of the mucous passages.

51. The mucous membranes, by their perpetual secretion, perform a principal office in the animal economy. We must regard them as one of the great emunctories, through which incessantly escape the residue of nutrition, and consequently as one of the leading agents of the habitual decomposition, which removes from living bodies those particles which having contributed for some time to the composition of the solids, have now become heterogenous to them.

52. Observe that all the mucous fluids do not enter the circulation, but are rejected from the body; that of the bladder, of the ureters, of the urethra with urine, that of the vesiculæ seminales, of the vasa deferentia with the semen, that of the nostrils by blowing the nose, that of the mouth, in part by evaporation, in part by the anus with the excrements, that of the bronchia by the pulmonary exhalation, chiefly effected by solution in the air of respiration, of this mucous fluid, those of the œsophagus, of the stomach, intestines, of the gall bladder, etc., with the excrements of which they often form, in the ordinary state, almost as large a part as the remainder of the food, and in certain dysenteries they compose almost the entire evacuations, and in certain fevers, in which the substances voided are evidently disproportioned to

those taken, etc. We may remark on this subject, that there are always some mistakes in the analysis of fluids in contact with these membranes, as the urine, bile, gastric juice, etc., because it is very difficult, or impossible, to separate from them the mucous fluids.

53. If we call to mind what has been said on the extent of the two general mucous surfaces, equal and even superior in extent to the skin; if we then consider these two great surfaces as always excreting the mucous fluids, we shall perceive of what importance this evacuation must be, in the animal economy, and what injuries must follow its derangement. It is doubtless to this law of nature, which ordains that every mucous fluid should be thrown out from the system, that we must attribute in the fœtus the presence of an unctuous fluid, with which the gall bladder is full, the mœconium distending its intestines, etc., species of fluids which seem to be a mere mass of mucous secretions, which not being evacuated remain, till birth, on the respective organs where they were secreted.

54. The mucous secretions are not the only fluids thrown out of the body, and thus serve as emunctories in the economy; almost all the fluids, separated from the body by secretion, are in this case; this is evident as to the greater part of the bile; probably the saliva, the pancreatic juice, and the tears are also ejected with the excrements, and that their colour only prevents their being as clearly distinguished as the bile. I do not know even, if in reflecting on a multitude of phenomena, that we might not be tempted to establish as

a general principle, that every fluid, separated by secretion, does not re-enter the circulation; that this phenomenon pertains only to the fluids exhaled, as those of the serous cavities, of the articulations, of the cellular tissue, of the medullary organ, etc.; that all the fluids are thus excrementitious or recrementitious, and that no one is excremento-recrementitious., as the vulgar division indicates.*

55. What however is certain is, that I have never been able to make the lymphatics absorb bile and saliva, when injected into the cellular tissue of an animal; these fluids have constantly occasioned inflammation and suppuration. 2. It is also known that infiltrated urine is not absorbed, and strikes dead all it touches, while the infiltrations of lymph, and of blood are easily resolved. 3. There is an essential difference between the blood and the secreted fluids, in regard to decomposition. On the contrary, in this respect, fluids exhaled resemble it considerably, as the serosity, etc. But this discussion would lead us far from the limits which should be observed here; we shall return to it in another work.

§ 4. *Vasscular system of the mucous membranes.*

56. The mucous membranes receive a very great number of vessels. The remarkable redness which

* The bile in the gall bladder, the urine in the bladder, the semen in the vesiculæ seminales, are certainly absorbed; but this is not the fluid itself which re-enters into the circulation; they are its finer parts, some of its principles with which we are not well acquainted, probably the aqueous, lymphatic part; this does not resemble the absorption of the pleura and other analogous membranes, where the fluid re-enters the blood as it passed from it.

distinguishes them would be sufficient to prove this, though injections should not demonstrate it; this redness is not every where uniform.

Less in the bladder, the large intestines, the sinuses of the face, it is decisive in the stomach, the small intestines, vagina, etc. It depends on a vascular network extremely multiplied, whose branches, after traversing the corion, and being ramified in it, disappear in numberless divisions on its surface, there embracing the corpus papillare, covered only by the epidermis.

57. The superficial position of these vessels frequently exposes them to hemorrhages, as we chiefly remark in the nostrils, in hemoptysis, in hematemesis, or vomiting of blood, in hematuria, or bleeding from the urinary passages, in certain dysenteries wherein the blood escapes from the intestinal parietes, in uterine hemorrhages, etc.; so that spontaneous hemorrhages, independent of any external violence to the open vessels, seem to be a special affection of the mucous membranes, as it is rare to observe them except in these organs; they form at least one of the great characters which distinguish them from all the other membranes.

58. The superficial position also of the vascular system of the mucous membranes, which renders their portions visible, as the red border of the lips, the glans, etc., often serve to point out the state of the circulation.

Thus in the divers kinds of asphixia, in submersion, strangulation, etc., these parts become livid, the

effect of a difficult transmission of the venous blood through the lungs, and of its reflux toward the surfaces where the system of veins originate from that of the arteries.

59. I have already observed that in the fœtus and new-born infant, the vascular system was as manifest in the cutaneous organ, as in the mucous membranes; that the redness was the same in both: it is even more striking in the early periods of conception; but soon after birth all the redness of the skin seems to be concentrated in the mucous membranes, which, before inactive, did not require so full a circulation, but which suddenly becoming the seat of the phenomina of digestion, of the excretion of the bile, of the urine, saliva, etc., should receive a greater quantity of blood. Besides, the long continued exposure of the mucous membranes to the air, frequently deprives them of this redness which characterizes them, and they then take the aspect of the skin, as M. Sebatier has very well observed, in treating of the prolapsus of the womb and vagina, which, by this circumstance, have sometimes imposed the belief of an hermaphrodite.

60. An important question presents itself in the history of the vascular system of the mucous membranes, whether this system admits more or less blood, according to different circumstances.

As the organs, on the inside of which these membranes are spread, are nearly all susceptible of contraction and dilatation, as is seen in the stomach, intestines, bladder, etc., it has been thought that during dilatation, the vessels more diffused received more

blood, and that in contraction, on the contrary, folded on themselves, as it were strangulated, they would admit but a small quantity of this fluid, which then flows back to the neighbouring organs. M. Chaussier has applied these principles to the stomach, whose circulation he has considered as alternately inverse with that of the epiploon, which receives, during the vacuity of that organ, the blood which the latter, when contracted, cannot admit. Since the time of Lieutaud, a similar use has been attributed to the spleen.

The inspection of animals opened in abstinence, and at different periods of digestion, has shown me on this subject;

61. 1. During the fulness of the stomach, the vessels are more apparent on the exterior of this viscus, than during its vacuity; within, the mucous surface is not more red, it sometimes appeared to me to be less so. 2. The epiploon, less distended during the plentitude of the stomach, exhibits nearly the same number of apparent vessels, as long, but more bent on themselves, than in the vacuity.* If they are then

* This is a necessary consequence of the disposition of the vascular system of the stomach. In effect, the great coronary of the stomach being transversely situated between it and the epiploon, and furnishing branches to both, it is evident that when the stomach collapses, it separates thence, between the laminæ of the epiploon, and the latter, in applying itself over it, becomes shorter; it is, I say, evident, that the branches which it receives from the coronary, cannot also be equally applied to it. For this purpose it would be requisite that they be carried from one to the other, without the intermediate trunk which intersects them at right angles; then, in distending, the stomach would separate them like the epiploon, and would be collapsed between them; whereas it pushes them before it with their common trunk, the coronary, and throws them into folds.

less gorged with blood, the difference is hardly perceptible. It is requisite to distinguish this well, to take care in opening the animal, that the blood does not fall on the presenting epiploon, and thus prevent a clear distinction of its state. 3. I am assured that there is not so constant a relation between the volume of the spleen and the vacuity or plenitude of the stomach, that these two circumstances coincide in a necessary manner, and that if the former organ augments and diminishes in different circumstances, it is not always precisely in an inverse ratio with the stomach. Like Lieutaud, I had at first made some experiments on dogs, to assure myself of it; but the unequal size and age of those brought to me, making me apprehensive that I should not be able accurately to compare their spleen, I repeated them on Guinea pigs of the same litter, of the same size, and examined at the same time, some while the stomach was empty, and others during its fulness. I have almost always found the spleen of nearly the same volume, at least the difference was not very sensible.

Yet in other experiments, in different circumstances, I have seen inequalities in the spleen, and especially in the weight of this viscus, but that was indifferently during or after digestion.

It seems after all this, that if, during the vacuity of the stomach, there is a reflux of blood toward the epiploon and spleen, this reflux is less than has been commonly said. Otherwise during this state of vacuity, the numerous folds of the mucous membranes of this viscus, leaving it, as we have said above, al-

most as much surface, and consequently as many vessels as during its plentitude, the blood should here circulate almost as freely. It has then no real obstacles except in the tortuosities, and not in the restriction, constriction, or strangulation of these vessels by the contraction of the stomach; and this obstacle is easily surmounted.

62. As to the other hollow organs, it is difficult to examine the circulation of the neighbouring organs during their plenitude and vacuity, seeing the vessels of these are not superficial, as in the epiploon, and that they are not insulated like the spleen.

In order to decide this question, we need only to examine the state of the mucous membranes, on their internal face; now this face has always seemed to me as red during contraction as in dilatation.

Besides, I give this only as a fact, without pretending to draw from it any consequence opposed to the common opinion. It is possible that though the quantity of blood may be always nearly the same, the rapidity of the circulation increases, and that by consequence in a given time, more of this fluid may arrive during the fulness; this seems necessary to the secretion of the mucous fluids, at this time more abundant.

§ 6. *Varieties of organization of the mucous membranes, in different regions.*

63. The assemblage of the epidermis, of the corpus papillare, of the corion, of the glands, and of the vessels, constitute, in the mucous membranes, their

intimate organization, which presents very great varieties, in the different regions wherein they are examined. I will only point out the principal of these varieties; for in no place do these membranes exhibit the same aspect, and to describe all their differences, it would be necessary to examine them all.

64. One of these varieties is that, which the aspect of the mucous membranes offers, at their origin, compared with that under which they are presented in the depth of the organs. Compare, for example, the surface of the glans, of the free edge of the internal face of the lips, of the gums, inside of the eyelids, the beginning of the urethra, of the anus, of the vulva, etc., with any portion of the surface of the stomach, of the intestines, etc., and you will see, on the one side, the papillary body but obscurely, exhibiting no villous form, the epidermis thick, very distinct and easily raised, the corion well marked, the vessels somewhat less superficial, the mucous glands greatly multiplied, very large, especially in the mouth; on the other, you will meet characters nearly opposite.

We should say that, at their origin, the mucous membranes have a middle structure between that of the skin and that of their deep portion.

65. Another variety of structure not less striking, is that found in the portion of mucous surface lining the sinuses. Rather greater redness, extreme tenuity, the impossibility of distinguishing the three different layers we have mentioned, no perceptible mucous glands, though there is a notable secretion of mucosity: these are the characters of these processes of the

pituitary membrane, considered as suited to increase the sense of smelling, but which do not perform this function in the manner commonly understood.

In truth, the moment an odour penetrates the nose, conveyed by the air, it is not instantly carried to the sinuses, on account of the extreme narrowness of the openings through which these cavities communicate with the nostrils; by degrees it enters them, impregnates all the air contained in them, and not being able readily to escape, it prolongs the impression, which soon evaporates from the pituitary membrane itself by the change of air. Thus the pituitary membrane is destined to receive the impression of odours, and its processes in the sinuses, to retain them.

66. The particular structure of that portion of the mucous membrane which lines the sinuses, and that of the production which is spread on the internal ear, is absolutely the same, with the difference of greater fineness in its tissue.

All anatomists call this membrane the periosteum of the drum of the internal ear. The following considerations prove that this is not a fibrous membrane, analogous to that which envelops the bones, but a mucous lamina, similar to that of the sinuses. 1. It is evidently seen to be continued with the pituitary membrane by means of the Eustachian tube. 2. It is habitually moist with a mucous fluid which this canal serves to excrete, a character foreign to the fibrous membranes, which are always adherent by their two surfaces. 3. No fibre can be here distinguished. 4. Its spongy appearance, though whitish, its softness, the fa-

cility with which it yields to the smallest resistance, is a character which the periosteum no where presents.

67. I pass over the other differences of the structure of the mucous membranes, in their different regions, differences every where real; I observe merely, 1. that these varieties distinguish them from the serous membranes, whose aspect is every where the same, as may be seen in comparing the pericardium, peritoneum, etc.; 2. that this variety coincides with the differences which are noticed in the sensibility of different portions of these membranes; thus an emetic irritates the stomach, but not the conjunctiva; the pituitary membrane is exclusively sensible of odours; the mucous surface of the tongue, of tastes, etc. On the contrary, the contact of all substances on the serous membranes denuded, produces phenomena exactly analogous, as will appear.

§ 7. *Vital energy of the mucous membranes.*

68. The sensibility of the mucous membranes is one of the great characters which distinguish them from the other similar organs.

This inherent power of organic bodies, variable in each part, easily developed in some, excited with difficulty in others, present in all, is susceptible of passing, when inflamed, from the most obscure state to the highest degree of intensity: this force or power is observable here by characters very similar to those of the skin, with which the mucous surface has, as we have said, strong marks of similitude of structure. To this analogy of sensibility must be referred many

appearances which are alternately presented, in an inverse order, on these two surfaces. I shall notice in succession some of these phenomena.

69. 1. When the temperature of the ambient air blunts the sensibility of the skin, by contracting its tissue, the sensibility of the mucous surface is remarkably augmented. Hence in winter, in cold climates, etc., when the functions of the skin are singularly limited, all those of the mucous membranes are proportionately increased; hence greater pulmonary exhalation, the internal secretions are more abundant, digestion more active, more speedily performed, and consequently the appetite more easily excited. 2. When, on the contrary, the heat of the climate, of the season, etc., begins to relax and open the skin, we should think the mucous surface is contracted in proportion: in summer, in the south, etc., a diminution of the internal secretions, of urine for example; the sluggishness of digestion, through defective action of the stomach and intestines; the appetite slow in returning, etc. 3. The sudden suppression of the functions of the skin often produces a morbid increase in that of the mucous organ. The cold air, which checks perspiration, frequently produces rheums, catarrhs, a sort of affection, which is particularly characterized by the increased action and sensibility of the mucous glands. 4. In various diseases of the mucous membranes, baths which relax and open the skin produce happy effects.

70. The preceding considerations evidently confirm the influence of the vital power of the skin, over

that of the mucous membranes; others, not less important, demonstrate the reciprocal dependence of the skin and the vital energy of the mucous membranes.

1. During digestion, in which the mucous fluids distil in abundance from every part into the stomach and intestines, when the mucous membranes of the gastric viscera are by consequence in full action, the vapour of insensible perspiration sensibly diminishes, according to the observation of Sanctorius; it is in very sparing quantity three hours after taking food, so that the action of the cutaneous organ is visibly impaired. 2. During sleep, when all the internal functions become more obvious, and are fully performed, when the sensibility of the mucous membranes is consequently clearly characterized, the skin seems to be struck with a manifest debility, a debility which indicates the coldness, with which it is seized when the animal remains exposed, as during a watching; its defect of feeling for divers excitants, etc.

71. As in the skin, the sensibility of the mucous membranes is essentially subjected to the immense influence of habit, which tending incessantly to lessen the quickness of the feeling of which they are the seat, reduces equally to indifference the pleasure and pain which they occasion, and of which it is the middle term.

72. I said in the first place, that habit makes indifferent the painful sensations arising from the mucous membranes. The sound entering the urethra for the first time, is for the first day almost intolerable, painful in the second, inconvenient the third, impercepti-

ble the fourth; pessaries in the the vagina, plugs fixed in the rectum, tents tied in the nasal fossæ, the canula in the nasal canal, present, in different degrees, the same phenomena. On this remark is founded the possibility of introducing sounds into the trachea to supply respiration; and into the œsophagus for artificial deglutition. This law of habit can even transform to pleasure an impression at first painful; of which the use of snuff to the pituitary membrane, and of different aliments to the palate, furnish notable examples.

73. I said, in the second place, that habit reduces to indifference agreeable sensations, originating in the mucous membranes. The perfumer placed in an odorous atmosphere, the cook whose palate is incessantly affected with delicious savours, find nothing of those vivid gratifications, which they prepare for others.

From habit may even spring the succession of pain from pleasurable sensations; as in the preceding case it changes pain to pleasure.

I observe however, that this remarkable influence of habit is not exerted, except over sensations produced by simple contact, and not over those arising from a real lesion of the mucous membranes; thus it does not mitigate those sufferings from a stone in the bladder, or those in the womb from a polypus, etc.

74. To this force of habit over the vital powers of the mucous membranes, is in part to be referred the gradual diminution of their functions in age. Every thing excites the infant, every thing is blunted in old men.

In the former, the very active sensibility of the alimentary, biliary, urinary, salivary, and other mucous surfaces, principally concurs to produce that rapidity with which the digestive and secretory phenomena succeed each other; in the latter, this sensibility, blunted by the habit of contact, but slowly connects the same phenomena.

75. Does not that remarkable modification of the sensibility of the mucous surfaces come from the same cause; to wit, that at their origin, as in the pituitary membrane, the palate, the glans, the orifice of the rectum, etc., they give the sensation of the substances with which they are in contact, and that they do not communicate this sensation in the deep-seated organ which they line, as in the intestines, etc.? In the deep-seated organs, this contact is always uniform: the bladder perceives only the contact of the urine; the vesicula fellis only the bile, the stomach only that of the aliments, chewed and reduced, whatever be their diversity, to a pulpy homogeneous mass.

This uniformity of sensation is followed by no perception; because to perceive, it is necessary to compare, and here the two terms of comparison are wanting. Thus the fœtus has no sensation of the water of the amnios; thus the air, at first highly irritating to the new-born infant, after a time is not perceived. On the contrary, at the beginning of the mucous membranes, the excitants vary at every instant; the mind can then perceive their presence, because it can establish some comparisons between their different modes of action.

This is so true that if, in the interior organs, the mucous membranes are in contact with a body foreign and different from that to which they are habituated, they transmit the sensation of it to the mind.

The catheter in the bladder, sounds in the stomach, etc., are examples of it.

The fresh air, which in a very warm atmosphere is suddenly introduced into the trachea, conveys over all the surface of the bronchia, an agreeable sensation; but habit soon renders us insensible to this effect.

76. It is very difficult to point out exactly the character of the tonic powers of the mucous membranes, because being almost every where united to a lamina of muscular fibres, we cannot precisely distinguish what pertains to the tone of the former, from what depends on the irritability of the latter, or, if the mucous membranes are insulated, as in the nostrils, their adherence renders the phenomena of their tonic powers very obscure. Yet the action of the excretory ducts on their respective fluids, that of the gall-bladder, of the vesiculæ seminales which are deprived of muscular aid, the occasional spasmodic contraction of the urethra on the sound, leave no doubt of the energy of this tonic power, similar no doubt in its different modifications, to that which we observe in the skin.

§ 8. *Sympathy of the mucous membranes.*

77. I refer the sympathies of the mucous membranes, to three general classes, like those of most of the other organs.

In the first class we ranked the sympathies, in which the irritation of any one part of the mucous surface produces in some other part, the exercise of sensibility. A stone in the bladder occasions a pain at the end of the glans penis. Worms in the intestines excite an itching of the nose. Whytt saw a foreign body, introduced into the ear, excite a pain in the whole corresponding side of the head, and an ulcer in the bladder produce, every time the patient voided his urine, a pain in the superior part of the thighs, etc. etc.

78. I refer to the second class the sympathies wherein the irritation of some one point of the mucous surface produces in another part, the exercise of irritability: thus a too strong impression on the pituitary membrane excites sneezing; the irritation of the bronchia produces coughing; biliary calculi produce spasmodic vomiting; urinary calculi produce a retraction of the testicle to the ring, etc. etc. In all these cases there is a contraction of the muscles, caused by the irritation of the mucous surfaces, far from the place where this contraction takes place.

79. The last class of the sympathies of the mucous membranes, includes that wherein the irritation of some one point of their extent, causes in some other portion of it, the exercise of tone. To this we must refer what was said above on the glandular action, augmented by the irritation of the extremity of the excretory ducts. Thus it is evident, that the augmentation of the tonic powers of the parotids for the secretion of saliva, of its excretory duct for its trans-

mission, when the extremity of this duct is irritated by the aliment, by sialagogue medicines, etc., it is, I say, evident, that this increase of action is a phenomenon purely sympathetic.

We might characterize each of these three classes of sympathies, by the name of the vital power which each brings into action, in calling the first the sympathy of sensibility; the second, the sympathy of irritability; and the third, the sympathy of tone.

80. This mode of classing the sympathies, borrowed entirely from the state of the vital powers, of which they are nothing but irregular modifications, but aberrations still unknown in their nature, seems to me preferable to that of Whytt, who follows simply the order of regions; and even to that of Barthez, who, more methodical as he examines them in succession in the organs connected by systems, in those which are insulated, in those situated in the symmetrical halves of the body, is nevertheless subject, as I shall elsewhere demonstrate, to very serious inconveniences.

§ 9. *Functions of the mucous membranes.*

81. I have already examined several functions of the mucous membranes; I have considered them, 1. as one of the great emunctories of the animal economy; 2. as performing, in relation to heterogeneous substances within our organs, the same functions which the skin performs with regard to those exterior bodies which surround it; 3. as facilitating the passage of these foreign bodies, by the mucous fluid

which lubricates them. I have now to examine three questions, much agitated of late; namely, 1. whether the mucous membranes have an influence over the red colour of the blood; 2. whether there is any exhalation from this fluid; 3. whether the absorbents originate from these membranes, and consequently whether absorption is observed in them.

82. The visible redness of these membranes, the analogy of respiration wherein the blood is coloured through the mucous surface of the bronchia, the known experiment of a bladder filled with blood and immersed in oxygen, in which the fluid is also coloured, have led to the opinion, that the blood being only separated from the atmospheric air, by a thin pellicle over certain mucous surfaces, as in the pituitary membrane, the palate, glans penis, etc., did there also assume a brighter hue, either by discharging a portion of carbonic acid gas, or by combining with the oxygen of the air, and that these membranes would thus perform functions accessory to those of the lungs. The experiments of Jurine on the cutaneous organ, which have been adopted by several celebrated natural philosophers, seem also to confirm the reality of their suspicion.

83. I tried the following experiment to assure myself of this fact.

I drew through a wound of the abdomen, a portion of intestine, round which a ligature was tied; I then returned it, keeping out a part through which was introduced atmospheric air, filling all the intestine above the ligature.

The intestine was then tied below the opening, and the whole returned to its place.

After an hour the animal was opened, and I examined the blood of the mesenteric veins arising from that part of the intestine distended with air, with the blood of the other mesenteric veins deriving their origin from the remainder of the duct. No difference of colour appeared; the internal surface of the portion of distended intestine had no additional rednesss.

I thought to obtain a more decisive effect by repeating the same experiment with oxygen, in another animal; but I perceived no variety in the colour of the blood. As in the mucous membranes ordinarily in contact with the air, this fluid is constantly renewed, and agitated by perpetual motion, and as in the preceding experiment it remained at rest, I attempted to produce the same effect in the intestines. I made two incisions into the abdomen, drew from each a portion of intestine, opened these two portions, adapted to one the tube of a bladder filled with oxygen, to the other the tube of an empty bladder; I then compressed the full bladder, so as to cause the oxygen to pass into the other, through the intervening sack of intestine, remaining in the abdomen, that the animal warmth might support the circulation.

The oxygen was thus passed several times from one bladder to the other, through the intestine, which, considering its contractility is more difficult, than is at first apprehended. The lower belly was then opened, and no difference was found between the venous

blood coming from this portion of intestine, and that flowing from other parts of it.

The superficial position of the mesenteric veins, covered only by a fine transparent lamina of peritoneum, and their volume, if the animal be somewhat large, render these comparisons very easy.

84. I think we cannot infer from what happens in the intestines, what does take place in the pituitary membrane, in the palate, etc., because, though similar, the organization may be different. We cannot here, as in the intestines, examine the venous blood returning from the part; but 1. if we consider that in animals, which for some time have respired oxygen, we do not find the pituitary membrane of the palate the more red; 2. if we reflect that the lividity of various parts of this membrane, in those cases of arphyxia from carbonic acid gas, depends, not on the immediate contact of this gas on the membrane, but on the reflux of venous blood towards the extremities, which cannot pass the heart, as has been demonstrated by Goodwin in drowning, and as happens in all cases where the blood, before death, experiences great difficulties in passing through the lungs; 3. if we remark finally, that in these circumstances, the contact of air, after death, does not change the lividity which the venous blood gives to the mucous membranes, though the skin is then much more permeable to every kind of aëriform fluid; we shall find it necessary to suspend our judgment on the colouring of the blood through the mucous membranes, till farther observations may decide the question.

85. This further experiment may throw some light on this subject. I inflated the peritoneal cavity of several Guinea pigs with carbonic acid gas, with hydrogin, oxygen, and with atmospheric air, to see if I could obtain, through a serous membrane, what I could never accomplish in a mucous membrane. At the close of these experiments, I found no difference in the colour of the blood of the abdominal system : it was the same as in an ordinary Guinea pig, which I always killed to make the comparison.

86. I think, however, that I have several times remarked, both in frogs, and in animals of red warm blood, as cats and Guinea pigs, that the infiltration of oxygen into the cellular tissue, gives after sometime a much brighter colour to the blood, than that which this fluid presents in the artificial emphysematous swellings, produced by the carbonic acid gas, hydrogen, and atmospheric air, circumstances in which the redness of the blood differs but little from what is natural. But in some other cases oxygen has had no influence in colouring the blood; so that though many experiments have been repeated on this point, I am not able to designate any general result. It seems that the tonic powers of the cellular tissue and the coats of the vessels winding through it, receive a much varied influence from the contact of the gases, and that according to the nature of this influence, the fibres contracting more or less, render these parts more or less permeable, both to the aëriform fluids, which tend to escape from the blood to unite with that of the emphysema, or to this last fluid, if it tends

to be combined with the blood; which produces, without doubt, the varieties which I have noticed.

87. Do the mucous surfaces exhale? The analogy of the skin would seem to indicate it; for it appears to be well proved, that the sweat is not a transudation through the inorganic pores of the cutaneous surface, but a true transmission through vessels of a peculiar nature, continuous to the arterial system.

88. It seems at first that the pulmonary perspiration taking place on the mucous surface of the bronchia, which has so much affinity with that of the skin, which increases and diminishes, as the latter diminishes or increases, and whose matter is very probably of the same nature; it seems, I repeat, that the perspiration of the lungs is made, at least in part, through the system of the exhaling vessels, and that if the combination of the oxygen of the air with the hydrogen of the blood contributes to produce it during respiration, it is but in very small quantity, and for the portion purely aqueous; it is necessary further to observe in this respect, that the solution of the mucous fluid, which lubricates the bronchia, in the air constantly inspired and expired, furnishes a considerable share of this vapour, insensible in summer, but notable in winter, which rises from the lungs.

The intestinal juice which Haller has particularly considered, which seems to be in less quantity than he estimated it, the gastric and œsophagean juices are very probably deposited by means of exhalation on their respective mucous surfaces. But in general it

is very difficult to distinguish with precision in these organs, what pertains to the exhalant system, from that furnished by the system of mucous glands, which, as we have said, are every where subjacent to them.

Thus we constantly see the mucous fluids of the œsophagus, of the stomach, and of the intestines, to be mixed with the œsophagean, gastric, intestinal, and other fluids, etc.

90. The absorbing power of the mucous membranes is evidently proved by those of the chyle on the internal surfaces, of the venereal virus on the glans and urethra, of the variolous virus with which the gums are rubbed, of the serous portion of the bile, of the urine and semen, when they rest in their respective reservoirs.

When in the paralysis of the fleshy fibres which terminate the rectum, the feces are accumulated at the extremity of this intestine (a common affection among old men, of which Desault cited many examples,) these materials often become hard, a probable effect of the absorption of the fluids here arrested.

There are divers instances of an almost total absorption of urine by the mucous surface of the bladder, in insurmountable obstacles of the urethra, etc.

Whatever be the mode of this absorption, it does not seem to be constantly done, without interruption, like that of the serous membranes, where the exhalant and absorbent systems are in a continual alternate action; but which does not take place, except in certain circumstances, of which the greater part

perhaps are not in the natural order of the functions. Besides, we have still less data respecting the manner of mucous absorption, than respecting that of the cutaneous absorption, which is but little understood, and of which many even doubt the existence.

§ 10. *Remarks on the diseases of the mucous membranes.*

91. It is no part of my object to examine the diseases of the mucous membranes. I shall merely point out some phenomena in these affections, which I think merit a particular attention, the explanation of which I propose for physiological physicians.

After inflammations seated in the mucous membranes, why do they hardly ever contract adhesions, as so often happens on the serous surfaces? Why is not the inflamed internal surface of the stomach, intestines, and bladder glued together in its different positions, like that of the pleura, tunica vaginalis, etc.?

93. In the inflammations of the mucous membranes why is there an abundant efflux of the fluid, which habitually wets them, constituting the various species of catarrh, while the source of the fluid, which is exhaled from the serous membranes, is commonly dried up in similar cases?

Does this second question correspond with the first?

94. Why do polypi, a species of disease peculiar to the mucous membranes, and which are never observed on other membranes, why do they rarely arise,

except at the origin of these mucous membranes, in the neighbourhood of the skin, as in the nose, pharynx, vagina, etc., and not in their deep portions, as in the stomach, intestines, etc.? Does this happen from the particular texture which characterizes, as I have demonstrated, the mucous membranes in the neighbourhood of places where they come from the skin; or are we solely to attribute this fact to more numerous causes of irritation, which act at the origin of these cavities?

95. Are not aphthæ an insulated inflammatory affection of the glands of the mucous membranes, while catarrhs are characterized by a general inflammation of all the parts of these membranes?

ARTICLE III.

OF THE SEROUS MEMBRANES.

§ 1. *Of the extent and number of the serous membranes.*

96. The serous, or lymphatic, or cellular* membranes, occupy the outside of most of the organs whose inside is lined by the mucous membranes; such are the stomach, the intestines, bladder, etc. They meet over those, subject to great motions, to reciprocal frictions, as in the articular surfaces and tendinous sheaths; they are seen over all the organs essential to life. The brain, the heart, the lungs, all the gastric viscera, the testicle, etc., borrow from them an exterior covering.

97. They do not form, like the mucous mem-

* This term is never applied to the serous membranes by English anatomists. Tr.

branes, a surface every where continuous over the numerous organs where they are displayed; but we always find them separate from each other, rarely having any communication. Their number is very considerable. Add to those of the great cavities, all those of the cavities of the joints, and of the tendinous capsules, and you will perceive that the extent of the serous surface, taken together, and considered as the sum of all these membranes in particular, far surpasses the mucous surface, considered also in a general manner.

98. A single consideration is sufficient to convince us of this. The mucous and serous surfaces accompany each other in a great number of parts, as in the stomach, the intestines, the lungs, the bladder, the gall-bladder, etc., in such a manner as to present nearly the same extent.

But, on the one hand, the mucous surfaces are extended where the serous do not occur, as in the nasal fossæ, the œsophagus, mouth, etc.; on the other hand, there is a very great number of serous surfaces existing separately from the mucous, as the pericardium, the arachnoides, the synovial surfaces of the joints, and the tendinous sheaths. Now if we compare the extent of the insulated serous surfaces, with those of the mucous surfaces also insulated, we shall see that the former is greatly superior to the latter.

99. These considerations, minute in appearance, merit however a special attention, on account of the connexion of functions, existing between these two surfaces taken in toto, a connexion which exists particularly

in the exhalation of albuminous fluids effected in the one, and the secretion of mucous fluids in the other. Farther, in examining the extent of each serous membrane in particular, we see infinite varieties, from the peritoneum, which seems to have the maximum of surface, to the synovial membranes of the cartilages of the larynx, which seem to present the minumum of it.

100. The sum of the serous surface, compared with the cutaneous surface, is evidently superior to it in extent; so that in this respect, the quantity of albuminous fluid, incessantly exhaled within, seems more considerable than that of the humour habitually thrown out by insensible transpiration: I say in this respect, for various circumstances, by augmenting the action of the skin, may reestablish the equilibrium in the exhalation of these two fluids, one of which reenters by absorption into the circulation, while the other is wholly excrementitious.

I am even doubtful whether the pulmonary and cutaneous exhalations united, are not less than that which takes place on the whole of the serous surfaces.

§ 2. *Division of the serous membranes.*

101. The class of serous membranes comprehends two genera essentially distinct. The first includes the pleura, the pericardium, the peritoneum, the arachnoides, the tunica vaginalis, etc., and in general, all the membranes of the great cavities.

The second embraces, 1. the capsules of the ten-

dinous sheaths, pointed out by Albinus, Monro, M. Sabatier; made known by Haller and Junker, described by M. Fourcroy and by Sœmmerring, under the name of *mucous* capsules, a name which gives a false idea of their structure, and which that of *synovial* would advantageously supply. 2. The synovial membranes, which I have described in the different articulations, and whose uses and structure I believe no one had before pointed out.

102. What confounds these two genera in the same class, is, 1. their common exterior disposition in form of a sack without opening; 2. their cellular texture; 3. the alternate exhalation and absorption which they perform. What establishes between them a real line of demarcation, is, 1. the fluids which lubricate the membranes of both, appear to differ in their composition, though there is a strong analogy between them. 2. In hydropic diatheses which simultaneously affect the cellular tissue and the serous surfaces of the peritoneum, of the pleura, etc., the disease does not extend to the synovial membranes, which indicates a difference of structure, though we are not acquainted with this difference. 3. Reciprocally, in dropsies of the joints, a rare affection; in ganglions, true dropsies of the synovial capsules of the tendons, there is no concomitant disease of the membranes of the great cavities.

§ 3. *Exterior organization of the serous membranes.*

103. Every serous membrane represents a sack

without any opening, spread over the respective organs which it embraces, and which are sometimes very numerous, as in the peritoneum, sometimes single, as in the pericardium, covering these organs in such a manner that they are not contained in its cavity, and so that if it were possible to dissect out their surface, we should obtain this cavity entire. This sack exhibits, in this respect, the same disposition as those caps doubled in on themselves, which are worn at night; a trivial comparison, but which gives an exact idea of the conformation of these membranes.

104. Conformably to this general disposition, it is easy to conceive that the serous membranes are never open to admit to their respective organs, the vessels and nerves which pass to, or from them, but always form folds to accompany them to the organ, thus making a sheath for them, which prevents their being contained in their cavities; this hinders the infiltration of the serosity which lubricates them, an occurrence which would take place through the contiguous cellular tissue, especially in their dropsy, if, like the fibrous membranes, they were pierced with holes for the passage of these vessels and nerves.

This disposition, peculiar to the membranes in question, is manifest at the entrance of the vessels of the lungs, of the spleen, intestines, stomach, testicles, joints, etc. It is very well seen in the arachnoides, a membrane essentially serous, as I shall state.

105. According to the general idea given of these membranes, it is also easy to conceive how most of them are composed of two parts distinct though con-

tinuous, and embracing, one, the internal surface of the cavity where they meet, the other, the organs of this cavity : thus there is a pleura costalis and a pleura pulmonalis, a cranial and cerebral arachnoides, a portion of peritoneum reflected over the gastric organs, and another over the parietes of the abdomen; one part of the synovial capsule of the tendous embracing the tendon, and the other covering the inside of its sheath, etc.

106. Though the serous membranes are insulated, communications between them sometimes exist; that, for example, of the epiploic and peritoneal cavities, and that of the cavity of the arachnoides with the cavity of the membrane lining the ventricles.

Some authors suppose, that certain communications exist between some synovial capsules of the tendons, and the inside of the neighbouring articulations. I have never been able to observe any thing of the kind.

There is but one instance of continuity between the serous and mucous membranes, that which, by means of the Fallopian tube, exists between the peritoneum and the uterine surface. How does the respective nature of the two membranes here change ?

107. One surface of every serous membrane is free, every where continuous with itself; the other adheres to the contiguous organs.

The first is remarkable, 1. for its polish; 2. by its serosity ; 3. by its habitual slipperiness.

108. The polish of the free, disconnected surface

of the mucous membranes, is a character by which they are particularly distinguished. All the organs, having this disposition, owe it to the covering which they borrow from these membranes; the liver ceases to be smooth and thining at its diaphragmatic edge, where the peritoneum leaves it; there is, in regard to this, a great difference between the aspect of the interior and posterior faces of the intestinum cœcum; the bladder is rugous wherever it wants the peritoneal covering; the cartilages of the ribs have not the polish of those of the articulations which the synovial membrane embraces, etc.

109. Does this remarkable attribute of the serous membranes depend on compression?

Their being exposed to continual rubbing and friction, seems to make it credible.

Bordeu so intended, when he said that all the parts of the lower belly were primarily covered with cellular tissue, which by pressure was changed to membranes; so that the peritoneum is partially formed on each gastric organ, and that these different parts give rise, in being united, to the general membrane. This explication of the formation of the peritoneum, is applicable, according to him, to the pleura, to the pericardium, and all the similar membranes.

110. If such is the progress of nature, 1. why, at whatever age we examine the fœtus, do we find the peritoneum and the serous membranes, as fully developed as their corresponding organs? 2. How are the numerous duplicatures of these membranes formed, such as the mesentery, the epiploon, etc.? 3. Why

do they not exist in some parts, though these parts are exposed to a degree of friction equal to that of the parts where they are found? Why is the bladder, for instance, without them on its sides, while its superior portion is lined with them? 4. Why are not serous surfaces also formed about the great vessels of the arm, the thigh, etc., which impress on the neighbouring organs a manifest movement? 5. Why is not the thickness of the serous membranes increased where the motion is the strongest, and diminished where it is least? Why, for example, is the thickness of the tunica vaginalis equal to that of the pericardium? 6. How can this friction and pressure produce within the system an organized body, while on the exterior it constantly disorganizes the epidermis? Why connect the whole vascular-lymphatic texture of the serous membranes with the pressure which produces them?

111. The impossibility of resolving these numerous questions proves, that it is not to a mechanical pressure that we are to attribute, either the formation of the serous membranes, or the polish of their surface; that their mode of originating is the same as that of the other organs; that they begin and are developed with them; that this polish is an obvious result of their organization, as the villosities of the surface of the mucous membranes depend on the texture of these same membranes. What would be said of a system in which these villosities should be attributed to the pressure of the food in the stomach, of the urine in the bladder, of the air on the pituitary membrane, etc. etc.?

112. The inner surface of every serous membrane is humid, with a fluid almost identical with the serosity of the blood, in the first genus of these membranes, such as the pleura, the peritoneum, etc., of a nature analogous, but a little more compounded for the second genus, which comprehends the synovial membranes of the articulations, of the tendinous sheaths, etc. The exhaling orifices incessantly pour forth this serosity, and incessantly it is taken up by absorbents. Its quantity varies; a mere dew in its natural state, it is exhaled in vapours when the serous surfaces laid open, permit the air to dissolve it. It is more abundant in dead bodies, because on the one part, the tonic force which prevented transudation, then easily acts by the ceasing of this power, and supplies the vital exhalation, in transmitting mechanically, by their weight, the fluids of the surrounding organs to the different serous cavities: because, on the other part, this same decline of tonic power is opposed to every kind of absorption; hence the delay, and accumulation of this fluid.

We know to what degree its quantity increases in the different species of dropsy, notably in that of the abdomen.

113. Does not this quantity vary according to the different conditions of the organs which the serous membranes inclose?

It has been long since said, that the synovia was exhaled in greater abundance during the motions of the joints, than when they rest. I have no data on this point founded on experiment; but I can affirm,

that I have several times observed in living animals, that the exhalation from the serous surface of the lower belly, does not increase during digestion, or at least if it is greater, absorption becomes more active, and that thus the surface of the peritoneum is no more humid than at other times.

I have opened the chest of many Guinea pigs, after making them run a long time to accelerate their breathing, nor have I been able to remark any increased humidity on the pleura.

114. What is the nature of the fluid of the serous cavities? In the pathologic state, in different dropsies, its albuminous nature is placed beyond doubt by the action of fire, of alkohol, and of the acids. It is difficult to analyse it in the sound state.

Hewson however, having collected a spoonful of it in large animals, found its composition the same as that of the fluid circulating in the lymphatic system, as that of the serosity of the blood, which is equally albuminous. The trials of this author, whose results every thing seems to confirm, need however to be repeated.

115. As to the humour of the articular surfaces and of the tendinous sheaths, it seems, though very analogous to that of the cavities, to differ from it by the nature of the albumen it contains. See on this subject the analysis made of it in the Annals of Chemistry.

116. The principal use of this fluid in lubricating the surfaces, is to prevent adhesions, an inevitable effect without it, of the friction which they experience.

This rubbing is continual wherever these membranes are found.

How is it that the mechanical authors of the last century, who in the organic economy have attributed so much to physical laws, have not imagined that they should find in this friction one of the causes of the propagation of animal heat?

Why has not this friction been added by them to that of the circulation?

117. The external surface of the serous membranes, almost every where adheres to the neighbouring organs; it is in fact rare to see these membranes insulated on both sides.

The arachnoides at the basis of the cranium, and some other examples, form exceptions. This attachment of the serous membranes to their respective organs, is altogether different from those of the fibrous membranes.

In the latter, the passage of the vessels so unites the two parts, that their organization seems to be in common, and that one being removed, the other almost always dies, as is seen in the periosteum in relation to the bones, etc. On the contrary, every serous membrane is almost foreign to the organ which it surrounds; whose organization is not connected with its own.

118. I shall examine hereafter the proofs of the first assertion relative to the fibrous membranes.

These are the proofs of the second assertion in relation to the serous membranes. 1. We very often see these membranes by turns leaving and again cov-

ering their respective organs. Thus the large ligaments, quite distant from the womb in the ordinary state, serve it as a serous membrane during gestation; the distended intestine borrows from the mesentery a covering which quits it when it contracts; the epiploon, as M. Chaussier has well observed, is successively a floating membrane in the lower belly, and a tunic of the stomach. Often the peritoneal envelope of the bladder abandons it almost entirely; has not the herniary sack of those enormous displacements of the gastric viscera, primarily served to line the parietes of the abdomen, etc.? Now it is evident, since the different organs can exist separately from their serous membranes, that there is no connexion between their reciprocal organization. 2. It is always a loose tissue, easily distended in all directions, which serves as a means of union, and never a sanguineous vascular system, as in most other adhesions. 3. The disease of an organ is not the necessary consequence of that of its serous membrane, and the contrary; the organ is often affected without the membrane's being diseased.

For example, in the operation for hydrocele, the testicle remains almost constantly untouched in the midst of the inflammation of its tunica vaginalis; the inflammation of the mucous membrane of the intestines is not the effect of that of their peritoneal covering, and reciprocally in the different acute catarrhal affections of the organs having a mucous membrane within and a serous membrane without, we do not see the latter inflamed, etc. In a word, the dis-

eases of the mucous membranes, are every where very distinct from those of the serous, though most commonly both contribute to the formation of the same organ.

It is evident that so real a line of separation of diseases, unavoidably supposes a difference of organization; the life then of the serous membranes is thus entirely separate from that of their corresponding organs.

119. Yet there are cases where these species of membranes do not present this laxity of adhesion, and where they become so closely united to the organs which they line, that the finest scalpel cannot often separate them. Such are the tunica vaginalis on the albuginea, the two layers, fibrous and serous, of the pericardium, the synovial membrane over the cartilages, the arachnoides over the dura mater, and other membranes, which we shall notice in the article on the sero-fibrous membranes, etc. Such is the connexion of these different surfaces, that several have hitherto been taken for a single membrane.

Still there is no more identity of organization, than where the serous membranes are more feebly attached to their respective organs, as is seen in the pericardium, pleura, etc.

§ 4. *Interior organization of the serous membranes.*

120. A whitish, shining colour, less striking than that of the aponeuroses; a variable thickness, perceptible on the liver, the heart, the intestines, etc., hardly

to be estimated in the arachnoides, epiploon, etc.; an observable transparency, whenever these membranes are divided in any considerable extent, or are examined where their two surfaces are free, disconnected, as in the epiploon: these are their first characters of structure.

121. They all have but a single lamina, from which it is possible, where it is thick, to remove cellular layers, but which can never be neatly divided into two or three portions, a character essentially distinct from those of the mucous membranes. The action of a vesicatory applied to their external surface, previously denuded, for example, on a portion of intestine fastened without the abdomen of a living animal, does not there, as on the skin, raise a pellicle collecting serosity.

I have several times made this trial. What is the immediate composition of this single stratum of the serous membranes?

122. Every organ is in general a union, 1. of cellular tissue, which is its mould or groundwork; 2. of a particular matter deposited in this mould, for example, of gelatin for the cartilages, of gelatin and phosphate of lime for the bones, of fibin for the muscles, etc.; 3. of vessels bringing and carrying this matter of nutrition; 4. of nerves.

The organs are connected then by the cellular organ, the vessels and nerves; they are distinguished by their matter of nutrition.

A bone would become muscle, if, without changing its texture, nature should impart to it the faculty

of secreting and consolidating fibrin, instead of calcareous phosphate.

Now the serous membranes do not seem to have a distinct nutritive matter; they are not in this respect, an organ *sui generis;* they are only formed in the mould, on the basis of others, and not penetrated with a matter which characterizes them. Being all formed of the cellular tissue, they differ only from this tissue in its common form, by a certain degree of condensation, and by an approximation and union of the cells, which are loose and separated in the ordinary state.

123. On the following proofs rests the reality of this mere cellular texture, which I attribute to the serous membranes: 1. there is identity of nature, where we find identity of functions and of diseases. Now it is evident, that the uses of these membranes and of the cellular tissue, relative to the continual absorption and exhalation of lymph, are absolutely the same, and that the phenomena of different dropsies, are common to them, with the single difference of effusion in the former and infiltration in the latter. 2. The inflation of air into the tissue subjacent to these membranes, nearly reduces them to a cellular state, when it succeeds and is pushed to some length. 3. Maceration, as Haller has well remarked, always produces the same effect, but in a manner still more sensible. 4. The various cysts, hydatids, etc., whose aspect, texture, and even nature, are absolutely the same as in the serous membranes, as will be seen, always originate in the midst of the cellular tissue, in-

crease at its expense, and are wholly formed of it. 5. No fibre is met in the serous membranes, a distinguishing character of the other organs, and analogous to that of the cellular tissue.

124. According to this texture of the serous membranes, it is evident, that the lymphatic system essentially enters into their formation, that they are probably a mere interlacing of exhalants and absorbents; for we know that the cellular organ is an assemblage of them; but this assertion, which analogy suggests, is further supported by direct proofs. 1. The dropsical fluid of the different cavities, varies in density and in colour; now, Mascagni has always noticed that the lymphatics of their vicinity contained a fluid exactly similar. 2. Two dead bodies, having an effusion of blood in the chest, presented to the same author the absorbents of the lungs gorged with blood. 3. In a man become emphysematous after being poisoned, the vessels were distended with air. 4. Injected into the abdomen or chest, coloured fluids are soon after found, it is said, in the neighbouring lymphatics, of the same dye. This experiment I have often repeated; the fluid injected was soon absorbed, but not its colouring matter, so that this matter, more condensed after absorption, tinged the serous surface, while the lymphatics retained their usual transparency. We should generally choose the abdomen for these experiments, because being quite exposed on the liver, the absorbents can there be easily examined. This absorbing power continues sometime after death; but care should be taken, to secure this power more certainly,

that the animal, if warm blooded, be kept in a bath of nearly its own heat. I have several times had occasion to be assured of this fact, and of observing with Cruickshank, that what Mascagni says on the absorption of human carcases, fifteen, thirty, and even forty eight hours after death, is at least extremely exaggerated.* 5. The following experiment serves me every year to demonstrate the absorbents; I macerate five or six hours in water, the heart of an ox; at the end of this time, the serous membrane of this organ, whose vessels were scarcely seen, now seems covered with them. 6. When the serous membranes inflame, we see the subjacent lymphatics distended, like them, with the red globules of blood, etc.

* Is it not to the continuance of this absorbing faculty after death, that the vacuity of the arterial system, then observed, is in part to be attributed?

Frequently in fact the arteries contain a pretty large quantity of the fibrous portion of the blood, in form of clots; but the serosity has always disappeared: now, as has been said, if the vacuity of this system was entirely owing to a last effort to throw the blood into the venous system which makes no resistance, while the venous blood finds great resistance from the fulness produced in the right auricle, by the quiescence of the lungs; if, I repeat, the emptiness of the arteries was wholly due to a similar cause, it seems that this cause should be as much exerted on the fibrous portion, as on the serous; that in this last effort the blood should pass in its natural state altogether into the veins: when then we find clots in the arteries, it is probable that they have not been able to expel all the blood, that the blood has been decomposed, that the serum has been taken up by the absorbents which open on their inner surface, and that the fibrous part has remained, as we see in the resolution of most ecchymoses. Does not this also happen in the heart, when it exhibits after death many fibrous coagula and no serosity? All these ideas however are but conjectures, which require further researches to be confirmed.

125. It seems therefore to be demonstrated, 1. that the absorbents open by an infinite number of orifices on the serous membranes; 2. that their roots, a thousand times interwoven among themselves and with the orifices of the exhalants, specially contribute to form the tissue of these membranes; 3. that the difficulty of distinguishing the absorbing and exhaling pores on their surfaces, is no just reason for denying their existence, this difficulty arising both from their extreme tenuity, and the oblique direction with which they open between the laminæ of these membranes; thus the oblique insertion of the duct of Warton, and even of the ductus choledochus, renders their inspection very difficult, though these ducts are incomparably larger; 4. that, according to this structure, we must regard the serous membranes disposed, as we have seen, in form of a sack without an opening, as great reservoirs intervening between the exhalant and absorbent systems, where the lymph, in passing from the one, remains sometime before it enters the other. Here it undergoes, without doubt, various preparations which we shall never know, because it would be requisite to analyze it comparatively in the two orders of vessels, which is nearly impossible, at least for the former, wherein it serves divers relative uses for the organs, about which it forms a humid atmosphere.

126. Do blood vessels enter the structure of the serous membranes? These vessels are very numerous about them, as we see in the peritoneum, pericardium, pleura, etc. They wind about on their exter-

nal surface, and there ramify; I have always doubted whether they really made a part of their tissue, and am even almost convinced of the contrary: the following considerations support my opinion. 1. When these vessels are injected, they are easily raised with the scalpel from the external face of these membranes, without affecting their continuity, which it is impossible ever to do in the fibrous or mucous membranes. 2. In examining these membranes where both their surfaces are free, no blood vessel is perceptible; of this the arachnoides at the base of the cranium, is an example. 3. The vessels frequently change their connexion with these membranes. I have proved in the note, page 48, that when the epiploon is applied over the stomach in its state of fulness, the vessels which it contains between its laminæ, do not mount with it over this viscus, because of the great coronary stomachic which opposes it. When dead bodies are injected, having voluminous herniæ, we do not see the vessels creeping in the ordinary state over the surface of the peritoneum corresponding to the ring, to extend inferiorly over the herniary sack.

It does not appear that the vessels, seen in the large ligaments of the womb, follow them in the extensive displacements which they suffer during pregnancy.

127. I think it probable then, that the serous membranes have no blood vessels; and that the nominal arteries of the peritoneum, pleura, etc., are but trunks spreading over their external surface, which may leave it when the membranes are displaced, being rather foreign to them, than entering into their

structure, to which the absorbent and exhalant systems almost entirely contribute. There are doubtless, by means of the exhalants, communications between the arteries and serous membranes; but nothing is yet precisely known of the nature, disposition, and even to a certain point, of the functions of these vessels.

§ 5. *Vital powers of the serous membranes.*

128. There is a very great difference between the sensibility of the mucous membranes, before examined, and that of the serous membranes; the latter deeply situated, beyond the contact of every foreign body, possess only an obscure sense of feeling; they are little capable of causing a painful impression by being irritated. Hence in a living animal, when laid bare and irritated by chemical or physical agents, the animal rests tranquil; but the action of these excitants, which in a sound state of these membranes is not at first felt, soon becomes very painful, if for the shortest time only, they are exposed to the air. But this phenomenon is not exclusively observable in them. All the white organs, the tendons, ligaments, cartilages, in a word, all the parts which Haller has called insensible, give little sensation to the animal, by the contact of external bodies, when it takes place in their natural state, when but just exposed; but if the presence of air, or other causes, irritate them, they inflame and become extremely sensible.

129. In order clearly to apprehend this essential fact, let us remark that there are two species of sensibility, one purely organic, the other relative. Organ-

ic sensibility is that faculty, by which an organ receives the impression of a body acting upon it, without transmitting this impression to the common centre; thus the glands are sensible to the blood which enters them; the excretory ducts to that of the fluids they contain, etc. On this species of sensibility turn the phenomena of digestion, circulation, respiration, of the secretions, absorption, nutritition, etc.; it presides over the interior life, the organic life, over that which is destined incessantly to compose and decompose the animal, to assimilate and excrete the substances which nourish him. The sensibility of relation is that by which our organs are not only susceptible of receiving the impression of bodies which act upon them, but also of referring this impression to the *sensorium commune;* by this sensibility the animal is related to or connected with every thing about him; on this depend the phenomena of the senses, of the brain, etc.; this presides over the exterior or animal life, thus denominated because animals alone possess it, the other life being common to them and to vegetables.

130. The organic sensibility is the principle, the element of the sensibility of relation; it is, so to speak, the first degree of it; so that when this is much augmented in any organ, it assumes the character of the sensibility of relation, and this organ refers to the common centre the impressions which it receives and which before it did not transmit, or but very imperfectly. It is evident that the effect of inflammation is to elevate the organic sensibility, and consequently to

make it pass to the state of the sensibility of relation. Thus it is easy to conceive how the tendons, bones, cartilages, serous membranes, and other organs, called by Haller insensible, impress no painful sensation on the animal, when they are irritated immediately after being denuded. In fact, as they are then in their natural state, and as in this state, the organic sensibility is their only attribute, they cannot transmit to the brain, any other than the general impression of contact. But if they remain a short time exposed, the air inflames them; the organic sensibility is transformed to that of relation. Every contact of a foreign body, not only becomes perceptible, but painful to the animal.

131. How does nature in thus augmenting the organic sensibility in a part, transform it to the sensibility of relation? how is this passage made from one to the other? Let us be content to announce the fact, without attempting to raise the veil which conceals its principle.

No doctrine of the vital powers can ever be any thing else than a series of data, founded on observation.

To point out phenomena, often to refrain even from investigating the connexion between them, is what we almost always have to do here.—I observe further, that a thousand causes beside the contact of air, by inflaming the serous membranes, may exalt their organic sensibility, and change it to that of relation, though these membranes be not denuded. The history of their phlegmasiæ is to be consulted on this point.

132. Is it to the excess of the sensibility of the mucous membranes over that of the serous, that we are to attribute the following phenomenon?

When the former pass out of the body, as in the prolapsus ani, vaginæ, etc., they always preserve nearly the degree of heat which is natural to them, unless there be strangulation. The second, on the contrary, when they are exposed in a wound, as we see in portions of intestine torn from the belly of an animal, soon grow cool, remain a long time at a low temperature, and do not acquire their ordinary warmth, till inflammation supervenes, and exalts their sensibility.

133. In this respect I have made a remark which strongly proves what is advanced above; that is, the distinctness of the life of the serous membranes, from the life of the organs, which they embrace.

In effect, though the portion of intestine, thus remaining in the air, is cold without, yet the corresponding portion of mucous membrane retains its heat, as one may be assured by splitting the intestine and introducing the finger, and if a portion of intestine is drawn out, so that it may be split in such a manner as to present, at the same time, to the air, a serous and a mucous surface, the former is already cold, while the latter has not yet lost any thing of its habitual temperature.

134. The tonic powers of the serous membranes are characterized, 1. by the absorption which they perform, and over which these powers so preside, that from the time any cause affects these membranes

with atony, absorption ceases, and dropsy ensues; 2. by the slow and gradual contraction which they experience after the natural or artificial evacuation of dropsical fluids; 3. by the sudden and manifest augmentation of these tonic powers, in cases where these aqueous collections are speedily evacuated, or rapidly repass into the circulation; 4. by the analogy of the cellular tissue, which, being the same in its nature and its vital properties with the serous membranes, possesses, as is known, a decisive tone or strength in certain places, in the dartos, for instance.

135. The serous membranes are endowed with an extensibility much less considerable, than the enormous dilatations of which they are, in certain cases, susceptible, would seem, at first view, to render probable. The mechanism of their dilatation evidently proves it. This mechanism arises from three principal causes: 1. from the unfolding of the plaits which they form; and this is the most influential of the three causes. Hence the peritoneum, that of all the membranes of the class, most exposed to dilatations from gestation, dropsy, visceral obstructions, there more frequent than elsewhere; hence, I say, the peritoneum presents so great a number of those folds. Hence also why we observe them especially about the organs subject to habitual alternations of contraction and restriction, as about the stomach, the intestines, uterus, and bladder: very manifest in the first state, less obvious in the second. 2. The enlargement of the serous cavities is owing to the displacements, of which their membranes are susceptible. Thus when the liver is con-

siderably enlarged, its serous membrane increases its extent in part, at the expense of that of the diaphragm, which being pulled, is detached and applies itself to the enlarged viscus. In an aneurism of the heart, I have seen the peritoneum, which could have yielded but very little, detached in part from that portion of the great vessels which it covers. 3. Lastly these membranes undergo in their tissue, a distention and real elongation. But this is in general the least sensible cause of the enlargement of their cavity; it is only in considerable distensions, that it has a marked influence; in ordinary cases, the too first causes are almost always sufficient.

136. Let us remark, in passing, that the increased extent of a part of the skin has often much analogy with that of the serous surfaces.

For example, in very large sarcoceles, the skin that covers them accommodates itself to their size; 1. by the developement of the folds of the scrotum; 2. by drawing the skin of the penis, of the upper part of the thighs, which applies itself over the tumour; 3. by a real extension of that which corresponds, in the common state, to the testicle.

§ 6. *Sympathies of the serous membranes.*

137. I have divided sympathies into three clases; namely, 1. into sympathies of sensibility, or into those wherein the irritation of one part produces a pain, or some feeling, in another part; 2. into sympathies of irritability, which are characterized by the

contraction of a muscular organ, after the application of a stimulus to another organ more or less distant; 3. into sympathies of tone, which are manifested when one organ being excited, another receives an addition of tonic power. I do not know any phenomena pertaining to the serous membranes, excepting the sympathetic phenomena of the first and third classes.

138. 1. We notice in phrenzy in which the arachnoides is irritated, an extreme sensibility of the eye and ear; 2. in the operation for hydrocele by injection, the irritation of the tunica vaginalis is often accompanied with very sharp pains in the lumbar region; 3. the inflammatory affection of the pleura of one side, is frequently the cause of a pain in the pleura of the opposite side, without observing, in the dead bodies, wherein this pain takes place, any inflammation on this side, etc. etc.

These are the sympathies of sensibility.

139. The sympathies of tone are characterized in the serous membranes, by the following appearances: 1. when even a very small portion of the peritoneum is irritated, as in pinching any point of the intestinal surface, the whole of the membrane is often inflamed. 2. The inflammation of the pleura has sometimes produced, as Barthez observes, that of the brain, and reciprocally; the inflammation of the two pleuræ often succeeds each other, then the affection of one arises sympathetically from that of the other. 3. If one portion of the mesentery of a reptile be irritated, all the contiguous parts receive an increase of tonic power; an increase which suddenly changes the direction

which this power did impress on the humours, and causes the irritated point to become the centre of the capillary circulation of the part. Haller, Fontana, and many others, have repeated these experiments. In all these cases, and divers others which I could add, there is evidently an increase of tone or power in some point other than that irritated. Barthez classes these and other similar phenomena, among the sympathies of the blood vessels.

§ 7. *Functions of the serous membranes.*

140. I have pointed out the functions of the serous membranes relating to the lymphatic system; I have exhibited these membranes as great reservoirs, interposed between the exhalant and absorbent systems, wherein the lymph is prepared, elaborated, etc. It remains for me to show their uses relative to the various organs over which they are displayed.

141. The first of these uses is doubtless to form about the essential organs a boundary, which separates them from those of their vicinity. Observe in fact all the principal viscera, the heart, the lungs, the brain, the gastric viscera, the testicle, etc. Limited by their serous envelope, suspended in the middle of the sack which it represents, they do not communicate, except where these vessels enter, with the parts adjacent; every where there is contiguity, but not continuity.

142. This separation of position coincides very well with the insulation of vitality which is remarked in all the organs, and especially in those which we have just pointed out. Each has its proper life, which

is the result of a peculiar modification, of sensibility, tone, and irritability; a modification which necessarily establishes one in the circulation, nutrition, and temperature. No part feels, moves, or is nourished like another, unless it pertains to the same system. Each organ performs in miniature, what occurs at large in the general economy; each takes from the circulating current, the aliment which suits it, digests this aliment, rejecting into the mass of blood what is heterogeneous to it, and appropriates what can nourish it; this is digestion in abridgment.

Doubtless the ancients meant to give an idea of this fact so well developed by Bordeu, who said that the womb is a living animal within another animal. It is then a very important use of the serous membranes, in rendering independent the position of their respective organs, to contribute to the independence of the vital powers, of the life, and functions of these organs. Let us not forget to consider in the same point of view, the humid atmosphere with which they incessantly encompass them.

143. A second office of the serous membranes, is to facilitate the moving of the organs.

Let us observe, that in this respect, nature has provided two means to accomplish this end; namely, the membranes, and the cellular tissue. In distributing externally the second of these means, she has specially destined the first to the internal motions; the polish, the humidity of the serous surfaces, is singularly favourable to them.

144. These internal movements are commonly

considered in an insulated manner only, with reference to the functions of the organ which executes them, in relation to the circulation as respects the heart, to respiration in regard to the lungs, digestion as to the stomach, etc.; but we must view them also in a general manner; we must regard them as conveying to every part of the machine, a continual excitation, which sustains and animates the powers and action of all the organs of the head, the chest, and of the abdomen, which receive less sensibly, than the organs of the limbs, the influence of external motions. It is these interior movements that excite, maintain, and unfold within, the phenomena of nutrition; as without, the motions of the arms, and of the lower extremities, favour the nutrition of the muscles there distributed; as we clearly perceive among bakers and other mechanical artists, who exercise particularly some one part.

In this way the serous membranes indirectly contribute to the nutrition and growth of their respective viscera; but they never have a direct influence over this nutrition, because, as I have elsewhere said, their organization and their life are very different from the life and organization of these viscera.

145. Should we, as some have done, regard the serous membranes, as serving as a kind of mould to determine the exterior form of the organ which they surround? We shall reject this idea, if we consider, 1. the laxity of their adhesions; 2. the facility with which they quit their organs and again cover them, as the organs contract or dilate; 3. the arrangement of

several, which but partially embrace these organs, as we see at the bladder, cœcum, etc.

146. I do not point out the particular uses of each, those of the pleura for example, relatively to respiration, which it favours by removing the costal portion from the pulmonary portion, etc.

§ 8. *Remarks on the diseases of the serous membranes.*

147. There are some questions, in the solution of which some notions, more extensive than those I have offered on the serous membranes, will perhaps one day have an influence.

148. Why are the lower serous surfaces, such as the tunica vaginalis, and especially the peritoneum, more frequently the seat of dropsies, than the superior surfaces, such as the pleura, the pericardium, and particularly the arachnoides?

149. In the hydropic diathesis of these different membranes and of the cellular tissue, why does not a similar affection appear in the synovial membranes of the articulations and of the tendinous sheaths? To what precise variety of organization does this difference pertain?

150. What connexion is there between the purulent and viscous exudation of the inflamed serous membranes, and the increase of secretion, which, in the same case, takes place in the glands of the mucous membranes?

151. Is not an exact parallel to be established, 1. between the adhesions of the serous membranes resulting from inflammation, and those of the reunion

of wounds by the first intention? Are not these adhesions in both cases the effect of inflammation in its first stage? 2. Between the purulent exudation of these membranes and the suppuration of wounds not united—are not both the effect of the second period of inflammation? If the identity of these phenomena is recognized, does it not depend on the identity of structure of the serous membranes and cellular tissue, an essential agent in the reunion and suppuration of wounds?

152. When adhesions of the serous membranes take place, in a surface somewhat large, does the lymphatic exhalation become proportionately more abundant on the remaining surfaces not adhering?

153. Do these morbid membranes, so common after inflammation of the pleura, arachnoides, etc. etc., form also in the articulations and synovial surfaces?

ARTICLE IV.

FIBROUS MEMBRANES.

§ 1. *Extent and number of the fibrous membranes.*

154. The fibrous membranes are very numerous in the animal economy. The organs they surround have no analogy among themselves, like those which the serous membranes cover, and which are all remarkable for more or less obvious motion, or like the parts on which are spread the mucous membranes, which are every where in contact with bodies heterogeneous to the animal.

We meet these sorts of membranes on the outside of the bones, of the eye, of the testicle, of the penis, kidney, etc. We see them spread over the circumference of the limbs, supplying them with a strong covering, in the interstices of the muscles, and round the articular surfaces; for we must rank among them the aponeuroses, the fibrous capsules of the joints, etc.

155. There is among all these membranes a remarkable continuity. The periosteum seems to be their common point of union; almost all arise from, terminate in, or communicate with it by different processes. The dura mater passing out through numerous holes of the basis of the skull, is continued with it, and unites with the sclerotica, sending to both a lamina; the membrane of the corpus cavernosun interweaves its fibres with its own under the ischium; it is the same in all the fibrous capsules, which are inserted above and below the articulation.

Nearly all the aponeuroses terminate in the serous membranes, whether they inclose a limb entirely, or furnish sheaths to the muscles, and points of insertion or termination. The pericondrium of the larynx, the tunica albuginea, that surrounding the kidney, appear almost alone to have an insulated existence. It follows from this, that we can conceive of the mucous surface, as of the fibrous, in a general manner; that is, as extending every where, connected at the same time with a multitude of organs, distinct over each by its form, its texture, and disposition, but being continuous in the greatest number, having almost every where communications. This manner of viewing it will appear still

more natural, if we consider that the periosteum, the general termination of the different portions of this surface, is itself every where continuous over the articulations, either by means of the fibrous capsules, which unite that of one of the two bones to that of the other, as in the humerus, femur, etc., or by means of the lateral ligaments which perform this office in the articulations, where, like that of the knee, we find no fibrous capsule, but merely a synovial sack. In thus considering the fibrous surface, it has an extent equal at least, if not superior, to that of the serous and mucous surfaces together.

156. The particular extent of each portion of this surface is in general proportioned to that of the organ which it includes. We do not see the sclerotica, the albuginea, and periosteum, form numerous folds, as in the peritoneum, pleura, etc.; or like the portion of mucous surface, which invests the small intestines; this is a distinctive character of the fibrous membranes, a character to which the dura mater alone forms an exception, by the processes which it sends between the lobes of the brain, those of the cerebellum, and between these two principal portions of the cerebral mass.

§ 2. *Division of the fibrous membranes.*

157. Though almost every where continued, the fibrous membranes make but one whole, but one single organ; there exist however between them differences, sufficiently well marked to divide them into two great classes. I rank in one, 1. the aponeuroses,

which may be separated into enveloping aponeuroses, such as those which surround the thigh, the leg, the arm, forearm, etc., and into aponeuroses of insertion; these are interposed between the fleshy fibres, to which they give origin, being continuous with them; 2. the fibrous capsules of the articulations, as of the femur and humerus, species of membranes, which anatomists have too much multiplied, and which, as I shall elsewhere demonstrate, exist but in a very small number of articulations, the greater part having only synovial membranes; 3. the fibrous sheaths of the grooves of the tendons.

158. I refer to the second class of the fibrous membranes, the periosteum, the dura mater, the covering of the corpus cavernorum, that of the kidney, the sclerotica, albuginea, the internal tunic of the spleen, etc. All these membranes are remarkable, and distinct from those of the preceding class, 1. by an immediate connexion with the organ they inclose; 2. because they make, as it were, part of its structure, the others being almost foreign to the parts over which they are spread, and having a life quite independent of theirs; 3. by divers other characters noticed in the following paragraphs.

§ 3. *Exterior organization of the fibrous membranes.*

159. I proceed to point out first the general characters of exterior organization which apply to all the fibrous membranes; I shall expose those of each of the two classes into which they have been distributed. 1. Every fibrous membrane has its two faces every

where continuous with the neighbouring parts, always adhering, never free, as is seen in one of the faces of the serous and of the mucous, never consequently moistened with a peculiar fluid, as these two classes of membranes are. 2. The greater part of them represent species of sacks, containing different parts. Thus the *fasica-lata* forms in the thigh a covering added to that of the integuments; the albuginea gives one to the testicle, the sclerotica covers the eye, the periosteum the bones, the fibrous capsules give a covering to the synovial membrane, etc. 3. This envelope is pierced with various openings for the passage of the vessels and nerves going to the parts subjacent, or passing from them, a character which distinguishes them from the serous membranes, which are always folded, and never open for the entering of vessels to the organs they embrace. These openings, formed by the mere separation of the fibres, are in general larger than the diameter of the corresponding vessels; which prevents their being pinched or strangulated in various circumstances.

160. The characters of exterior organization proper to the fibrous membranes of the first class, vary agreeably to the genera of this class, as we observe these characters in the aponeuroses, the capsules of the joints, or tendinous sheaths. The enveloping aponeuroses present a very variable form, agreeably to the part they embrace: sometimes in shape of cylindrical sheaths, as in the limbs, sometimes flattened like cloth, as before the abdominal muscles; they are all remarkable for their continuity with certain muscles, by

means of which the animal gives them the degree of tension, suited to limit or facilitate the movements of the part.

Each has its tensor muscles, whose gradual voluntary contraction thus varies at will its condition. This law of exterior organization is evident in the insertion, 1. of the auricular muscles, and of the two portions, frontal and occipital, in the epicranian aponeurosis; 2. of the strait muscles into the anterior aponeurosis of the abdomen, by means of the tendinous intersections; 3. of the great pectoral and latissimus dorsi muscles into the brachial, of the biceps into the antibrachial; 4. of the palmaris longus of the forearm into the palmar aponeurosis; 5. of the gluteus maximus, of the tensor vaginæ femoris, etc., into the aponeurosis of the same name; 6. of the semitendinosus, semimembranosus and biceps, into the tibial aponeurosis; 7. of the small posterior serrati into that which covers the muscles of the vertebral hollows, etc. etc.

161. This arrangement has the advantage not only of diminishing or increasing in general the extent of the aponeuroses, but also of adapting it with precision to the contraction of the muscles. Indeed, as most of those announced above are the essential agents of the motion of the part in which they are found, it is evident, that this part cannot be strongly moved without its aponeurosis being stretched with force; for the action of a muscle on the aponeurosis is not independent of that on the limb. Thus the biceps, in bending the forearm violently, necessarily extends with violence the antibrachial aponeurosis.

Now it is easy to conceive the advantage of the extension of the enveloping aponeuroses, during the contraction of the subjacent muscles, either in adding to their powers by some degree of compression, or by preventing all displacement of their fibres, a frequent accident in the gemini and soleus, which have no aponeurotic covering, corresponding in its resistance to the force of their movements.

This displacement occasions a sharp pain, and a momentary suspension of motion, phenomena which constitute the cramp.

162. Every fibrous capsule presents such an exterior organization, as to form a kind of hollow cylinder, whose two extremities embrace two heads of bones, and are continued into the periosteum. It is often pierced, not only with the common holes for the passage of vessels, like the fibrous membranes in general, but also with considerable openings for the transmission of tendons going to be implanted between it and the synovial membrane.

We see a striking example of this in the connexion of the subscapular muscle with the capsule of the humerus.

163. The tendinous sheaths, particularly remarkable on the palmar and plantar surfaces of the fingers and toes, represent in general half of a cylinder, longer or shorter, each edge of which fixed to those of the phalanges, there originates from the periosteum or interlaces with it. The bone completes the cavity which the tendon traverses, and which the synovial membrane entirely covers.

164. The characters of exterior organization of the second class of fibrous membranes, of the periosteum, sclerotica, and albuginea, differ greatly from the preceding.

These sorts of coverings correspond outwardly, by a loose texture to the organs which surround them. Ordinarily embraced by the muscles, they easily permit, by this connexion, their different movements, and often assume, where the friction is great, a cartilaginous texture, by the exhalation of the gelatine between the fibres with which they are encrusted. This disposition is improperly designated by the name of *indurated periosteum*, when this membrane presents it.

The inner surface of these membranes, being intimately united to the organ which they inclose, sends into it various continuations, which identify their existence with its own. A bundle of fibres are detached from the periosteum, and penetrate the bone; the dura mater also sends many filaments into it; from the albuginea, from the covering of the corpus cavernosum, from the tunic proper to the spleen, proceed fibrous appendages which, crossing in different directions within the organ, form the ground work and frame, around which its other constituent parts are arranged and supported.

166. According to this we should consider the membrane itself, as the mould which determines the form and size of the organ. Thus we see it, when the membrane is removed, push out irregular shoots. The callus, in cases of removal or loss, being too considerable to permit the passage of the periosteum over the divided surfaces, is unequal, rough, beset with asperities, etc.

The figure of the testicle is altered after its tunica albuginea is in any part injured, etc. This character distinguishes it from the serous membranes which can, without producing any lesion in the form of their respective organs, leave it, as we have seen, more or less extensively, or even entirely.

§ 4. *Interior organization of the fibrous membranes.*

167. To whatever class they may pertain, the fibrous membranes have always very nearly the same organization. Most of them of a deep gray colour, become in the aponeuroses, of a shining white. When dried they are all, like the tendons in that state, yellowish, semitransparent, elastic; of a middle thickness between that of the serous and mucous membranes.

168. Ordinarily formed of one, they have sometimes two laminæ, like the dura mater; but they are not distinct here as they are in some other parts, the sinuses, for example; every where else their separation is almost impossible.

It is commonly said that the internal layer, by folding on itself, forms the falx, the tentorium cerebelli, etc. This disposition is imagined, but not demonstrated.

I compare these processes to those which the aponeuroses covering the limbs send into the interstices of the muscles, with this difference, 1. that the first are free, unattached, on all sides, while the latter, on the contrary, furnish many points of attachment; 2.

at the origin of the former there is a separation of fibres for the sinuses, while in that of the latter, nothing of the kind appears.

169. All these membranes have, as a common basis, a fibre of a peculiar nature, hard, elastic, insensible, little contractile, not resolvable by maceration, as Haller has said, into cellular tissue. This fibre, very abundantly diffused in the animal economy, is also the essential principle of the structure of the tendons and ligaments, which differ only from the fibrous membranes, in being made up of bundles of this fibre always parallelly disposed, sometimes intercrossed; while in these membranes, it is interlaced in form of a delicate network of large surface. Thus the nervous fibre is extended into membrane in the retina, collected into lengthened parcels in the nerves. Thus the muscular forms alternately, both fleshy fasciculi in the locomotive muscles, and membranous laminæ in the stomach, the bladder, etc. The organic nature remains the same in these varieties of conformation.

170. It is doubtless from the identity of nature of the fibre of the tendons, of the ligaments, and that of the fibrous membranes, that we always see these organs interwoven and continuous. We know, 1. that the ligaments and periosteum every where unite together; 2. that most of the tendons originate from this membrane, or terminate in it; 3. that these whitish and fibrous cords have also their insertion in the sclerotica, and the covering of the corpora cavernosa; 4. that some, as those of the muscles of the eye, seem to be confounded with the dura mater. This contin-

uity of the tendons is not observed in any other organ, especially it is never seen in the serous and mucous membranes.

171. If we compare this observation with that which has demonstrated most of the fibrous membranes to be continuous with each other, it will be seen, 1. that the extent of the fibrous organ, considered in a general manner, is much more extensive than we first announced it, since we must add to it also the tendons and ligaments. 2. That this organ is every where connected, tied together, and forms a continuous body, of which the periosteum is, as it were, the centre, origin, and termination.

172. This fundamental fibre, the essential basis of the membranes in question, is not disposed in all, after the same manner. The sclerotica, albuginea, dura mater, etc., present us an interlacing, which, varied in a thousand directions, appears absolutely inextricable. This intertexture becomes less complicated in the periosteum; it is done only two or three ways, in the aponeuroses and fibrous capsules; it disappears in the ligaments which are formed, as has been noticed, of parallel fibres.

173. I observe that there are in the animal economy, but three well distinguished fibres; 1. that of which we treat; 2. the nervous; 3. the muscular; the cellular tissue not being fibrous. Each in its respective organs, namely, the tendons, muscles, and nerves, is very distinct, clearly manifest, because it here exists separately, and forms these organs almost entirely; but may not nature combine them, two to

two, three to three, etc.? Is it not to this combination that we are to attribute the properties of certain organs which partake equally of those of these three primordial fibres? By this combination I do not mean the common intermixing of the muscles with the visible nerves sent to them, of the same muscles with their tendons, etc.

174. Whatever be the insulated or combined state of these three fibres, they are evidently quite distinct in their nature, and it is impossible to admit the opinion of a multitude of anatomists who, observing that internal compression sometimes changes the muscles into a whitish body, dense and compact, have supposed the muscular fibre the same as that of the tendons, and consequently, as that of the fibrous membranes. In the muscles the same fibre is, according to them, alternately fleshy and tendinous.

How can we admit the unity of nature where there is a difference of external and internal organization—of vital properties, of functions, and even of diseases?

Now the least comparison between a tendon and muscle demonstrates these differences, which I do not stop to examine. There is certainly less analogy between the muscle and the tendon which receives its insertion, than between the latter and the bone, which, in its turn, gives it attachment in the adult.

175. What is the nature of this white fibre, the common basis of the membranes under consideration? We do not know, because we know not whether it possesses any decisive properties, it has

only the negative properties of the muscular fibre, which is evinced by contractility, and of those of the nervous fibre, distinguished by sensibility; it is almost always seen in a passive state. To this every fibrous organ is indebted for its strength, for that resistance which is proper to it, and which is found only in a small number of other organs.

It establishes between those organs where it exists, and the skin, cartilages, serous membranes, etc., an essential difference of structure; therefore the ordinary division of the organs into white and red is manifestly defective, because in the class of white parts, we confound, with the fibrous organs, both those which the cellular tissue alone forms, and those which, being of a different texture, have not this fibre for a basis.

176. This fibre is not equally developed at all ages; several fibrous membranes, hardly present any trace of it, in the fœtus. In considering the phrenic centre, several aponeuroses and even the dura mater, in the first months, we find in them the appearance of serous membranes, and a texture altogether cellular; the fibres are but slowly developed, and end at last, if I may use the expression, by usurping the whole membrane.

177. The vascular system of the fibrous membranes is well marked; it penetrates their tissue, and evidently enters into their composition. We often see the vessels spreading in numberless ramifications on the membrane before they penetrate the organ which the membranes cover. Some anatomists, ac-

cording to this, have considered them as suited to quicken the circulation, and thus to supply the force of the heart which must be enfeebled on their surface; but their small contractility, and their adherence to the parts assigned for this use, seem evidently to weaken it.

178. It seems certain, that there is a remarkable relation, though little known, between the circulation of these membranes and that of the organ which they surround. If we destroy the medullary system, the bone dies; the circulation within its cavity ceases; all its vascular system seems to turn outward on the periosteum, which then becomes red, thick, very sensible, and at last ossifies. By the inverse experiment, that of destroying the periosteum over a considerable portion of the bone, with the precaution of leaving the essential trunks, we unfold a more active circulation in the medullary system which also becomes bony; it is said this experiment has been successfully done by several living anatomists; it has always been attended with extreme difficulty with me, and never with success.

179. Are the fibrous membranes furnished with nerves? Judging from dissection, we may answer no; from various phenomena of their sensibility, one may feel assured of the affirmative. But are these phenomena irrevocably connected with the presence of these medullary cords, such at least as we see them in other organs?

§ 5. *Vital powers of the fibrous membranes.*

180. Haller has placed the fibrous membranes among the insensible organs, because when irritated by various chemical and mechanical agents, they do not convey to the animal any painful sensation; but I have already remarked, that this property, restricted within too narrow limits by this great man, possessed two well marked degrees; the first, where the organ seems to be the boundary of the impression which it receives; the other, where this impression is conveyed to the brain.

181. The sensibility of the serous membranes is that of the first degree; the different excitants produce over them, in their sound state, an effect similar to that of the fluids which they receive for nutrition; they feel the stimulus, but do not transmit this feeling, at least but very confusedly.

I compare this state to that of a region become paralytic; the organic sensibility certainly exists in this region, because the fluids circulate, and the secretions are performed in the part, etc.; but the sensibility of relation is extinct.

The fibrous membranes are naturally what the teguments of this region accidentally become. Let us further remark, that here, as in the fibrous membranes, inflammation so exalts the organic sensibility, that it is transformed into that of relation, as may be seen in the denuded periosteum, in the dura mater, which exfoliates after the trepan, etc.

182. Though after a very great number of exper-

iments on living animals, the sensibility of relation seems nothing in the fibrous membranes, and in the similar organs which form part of the fibrous body considered in general, there is however a mode of excitation which developes it in a remarkable manner in the ligaments, with which they have so great analogy of structure.

Lay open an articulation in a dog, that of the leg for example; dissect with care the organs which invest it; remove all the nerves, leaving nothing but the ligaments; irritate these with a chemical or mechanical agent; the animal remains unmoved, giving no sign of pain. After this extend these same ligaments by twisting the joint; the animal instantly struggles, is agitated, howls, etc.

Then cut off these ligaments so as to leave only the synovial membranes of this articulation, twist the two bones in opposite directions; this twisting ceases to be painful.

183. It results from this experiment which I have often repeated, that the ligaments, insensible to agents which cut, tear, and disorganize them, have great sensibility to those which stretch them beyond their natural degree. They have then their mode of the sensibility of relation, and this mode is analogous to their functions.

Removed by their position from all exterior excitation which can chemically or mechanically affect them, they have no need, like the skin exposed to this sort of excitation, of a sensibility which transmits the impression of it. On the contrary, very subject

to be distended, pulled, twisted in the violent motions of the limbs, it was necessary that they should give notice of this kind of irritation to the sensorium, whose excess might otherwise become fatal to the articulation. Thus nature accommodates the sensibility of each organ to the different exciting powers which it may experience, to those, above all, which would become dangerous, if the mind were not advertised of them; because this vital power is the essential agent which watches over the preservation of the animal.

Let us remark, from this example, that we should never pronounce on the insensibility of an organ, without exhausting on it every means of irritation. Now, as Grimaud says, who can know all these means? who can know all those with which the proper sensibility of the various parts is found to be particularly related?

184. To this mode of sensibility of the ligaments, and fibrous capsules, we must principally attribute, 1. the sharp pains which accompany luxations; 2. those still more severe experienced by the patient during the extension required to reduce them, as in old luxations, when we are obliged to use considerable force; 3. the intolerable sufferings of the punishment formerly resorted to in some countries, which consists in plucking and drawing asunder, with four horses, the limbs of the criminal.

In all these cases when the extension begins, it is not sufficient to affect the skin, and the nerves, always loosely disposed about the joint. The ligaments

alone are pulled, and may be the seat of the pains; but if the extension is increased, all the neighbouring parts of the articulation conspire to produce them.

185. It is doubtless to the insensibility of the fibrous membranes for one mode of excitement and to their sensibility for another, that we are also to refer the contradictory results presented by the experiments of Haller, of Zinn, of Zimmerman, of Walstorf, etc. on one side; of Lecat, of Lorri, of Benefeld, of Schlithing, etc., on the other, on the dura mater.

186. The tonic powers of the fibrous membranes become very manifest, 1. in the erection of the penis, whose envelope is alternately distended and contractracted, not by its elasticity, and the mechanical effort of the blood, but, as Barthez has observed, by a power proper to it, and which it receives from the vital principles; 2. in the contraction of the sclerotica after the puncture of the hydrophthalmic eye; 3. in the analogous phenomena which the testicle presents when its obstruction is resolved, and the fibrous capsules, when the synovia is evacuated in the articular dropsies, etc. I do not here speak of the contractility attributed by Baglivi to the dura mater, of its oscillations supposed by Lacase, and which were necessary to his ingenious system.

187. The fibrous membranes possess an extensibility which is evident in the dura mater in hydrocephalus, in the periosteum in the enlargement of the bones, in the ligamentous fibres in the vacillation of the symphisis pubis and ischiosacral articulation, in the aponeuroses in the different obstructions of the limbs, and in

general in all that class of the membranes, and in the various tumefactions of their respective organs; when the sack which they form is enlarged, it is not like that of the serous membranes, by the developement of their folds, but by a real extension, by a lengthening of their tissue; and what is then remarkable, is that they do not diminish, but even increase in thickness. This observation is easily verified in the albuginea of a schirrous testicle, in the sclerotica of an hydropic eye, etc.; we should say that the extension becomes a cause of irritation, which produces in these membranes, a more active nutrition.

188. This extensibility of the fibrous membranes is subject to an unvaried law; it can only act in a slow, gradual, and insensible manner. When a considerable tumefaction suddenly takes place in the parts subjacent, they cannot be distended with equal rapidity, and those strangulations supervene which are so common in the practice of surgery, resulting only from a want of proportion between the extensibility of the cellular organ and that of the fibrous membranes; the former being more promptly and easily brought into action than the latter.

§ 6. *Sympathies of the fibrous membranes.*

189. The sympathies of the first class, those in which the irritation of one part developes sensibility in another, are observable in the fibrous membranes: 1. when in periostoses which occupy but a small surface, the whole of the periosteum of the bone remain-

ing sound, becomes painful; 2. when in certain diseases of the hip joint, the patient experiences, in a sound knee, a sharp pain; 3. when after a bruise, or the puncture of the periosteum, in any one point, the whole limb becomes painful, etc. etc.

190. The sympathies of the second class, characterized by the contraction of certain muscles from the irritation of a distant organ, is pretty frequently seen in the fibrous membranes: 1. the puncture of the phrenic centre causes in the muscles of the face a contraction, producing the risus sardonicus; 2. the lacerations of the fibrous capsules of the joints, the puncture of the aponeuroses, the distension of the ligaments in luxations of the foot, are frequently accompanied by spasmodic motions in the muscles of the jaws; a well marked tetanus is often the result; 3. a splinter of a bone, fastened in the dura mater, has many times produced convulsive contractions, in different parts, etc. etc.

191. Finally, we find in the fibrous membranes sympathies of the third class, wherein from the irritation of one part, the tone of another undergoes remarkable changes, either of increase or decrease. 1. The dura mater being inflamed, the inflammation which always accompanies an excess of tonic power, is manifested in the pericranium, often in the sclerotica, etc. 2. The irritation of some extent of the periosteum evidently increases the powers of the medullary organ, when it becomes the nucleus of a new bone, etc. etc. Besides, several of the phenomena here considered sympathetic, pertain perhaps to a series of functions

yet little known, a series or connexion which causes the diseases of one organ to depend on those of another, at times far distant.

Let us confess it, the word sympathy is often a veil for our ignorance of the secret springs which nature employs to connect between themselves, and to harmonize the innumerable results, which she obtains from a very small number of causes.

§ 7. *Functions of the fibrous membranes.*

192. It is much more difficult to assign the general uses of the fibrous membranes, than those of the preceding, because they have not between them so direct relations, and because more clearly marked differences separate the different species of them. We must therefore consider their functions in the two classes which have enabled us to divide them.

193. We find in the first the aponeuroses. The aponeuroses for tunics, 1. add to the limb a solidity which it could not receive from its cutaneous sheath; 2. they retain the muscles in their respective places; prevent their displacement, furnish them often with partial sheaths, as we see in the sartorius; thus the thickness and density of the aponeuroses are every where in direct proportion to the number of muscles. That of the arm is thin; that of the thigh remarkably thick; on the contrary, while it is not very obvious on the leg, especially behind, it is well marked on the forearm; 3. they concentrate the motion of the limb, favour the sliding of the muscles within, doing the same exteriorly for the skin, which in its various frictions is

often displaced; 4. they determine the outward form of the limb, which would otherwise constantly vary, from the laxity of the cutaneous organ; 5. they promote the venous circulation, by compressing the limb.

Thus varices of the deep seated veins which accompany the arteries are rare, while they are very common in the superficial vessels which are without the influence of this compression. This compression is imitated by art in the application of bandages, etc.

194. The uses of the aponeuroses of insertion are apparent; by these and the tendons, nature unites in a very small space, fleshy attachments, which on the bone would occupy too much room, and would require a size that would impede motion.

195. I pass over the functions of the articular capsules and tendinous sheaths; these are clearly discerned.

I merely observe of the capsules, that their intertexture with the periosteum secures the solidity of their insertion, because in the efforts of drawing which they experience, the movement, extending through the whole of the latter membrane, is there lost in part, and the danger of tearing the fibrous attachment is then lessened.

196. The fibrous membranes of the second class, such as the periosteum, sclerotica, cavernous coat, etc. 1. protect their respective organs from the impression of the neighbouring parts in their movements, from that of the muscles in particular, the friction of which might else prove destructive to them; 2. they possess an essential influence over the nutrition of the

organ which they cover, though we know not exactly the mode of this influence, which is particularly remarkable in the periosteum, by its relation to the bone; 3. their life, essentially blended with that of the organ, seems every where to confound its phenomena with those of their own; which generally makes it very difficult to determine these phenomena with precision. See further what I have said, in different places, of this article, on the uses of these membranes.

§ 8. *Remarks on the diseases of the fibrous membranes.*

197. Is there not a real line of distinction between the phlegmasiæ of the serous, and those of the fibrous membranes?

Can we refer to the same class, the inflammatory affections of the periosteum and capsules of the joints on one part, of the pleura, peritoneum, etc., on the other?

Should not, as we have seen, the essential difference between the two classes of the preceding membranes, in regard to exterior organization, texture, vital properties, functions, etc., establish one between their diseases? If it be true that the difference of inflammations of the mucous, and of the serous membranes, rests on their diversity of structure, why should not this diversity have the same influence here also, where it is so prominent?

198. After inflammations of the periosteum, sclerotica, cavernous coat, and other fibrous membranes, we see neither opacity, greater thickness, false or artificial membranes, adhesions, nor the turbid, lactescent

effusion of a serosity, which accompany the various inflammatory affections of the serous membranes; can these two inflammations therefore be of a similar nature?

199. Have not some morbid characters been attributed to the fibrous membranes, which belong to the serous laminæ, that are closely connected with them?

Thus the arachnoides intimately adheres to the dura mater, the vaginal tunic to the albuginea, etc. Has not a mistake been made in the seat of inflammation in this part, especially in phrenitis?

See what I have said above, article arachnoides. I think it would be requisite to resolve these numerous questions, before uniting, in the same class, the inflammations of the serous and fibrous membranes.

ARTICLE V.

COMPOUND MEMBRANES.

200. We have examined the simple membranes which may be referred, in the animal economy, to certain general classes. Often separate, these membranes sometimes unite, and from their combination compound organs result, which then take characters between those of their double basis. In surveying this combination in different parts, we find the following membranes, 1. *sero-fibrous;* 2. *sero-mucous;* 3. *fibro-mucous;* each will become the object of our researches.

§ 1. *Fibro-serous membranes.*

201. The serous and fibrous membranes have a manifest tendency to adhere to each other; in most cases where they are in contact, they exhibit this character: 1. the arachnoides spreads itself, as I shall prove hereafter, over the whole inner surface of the dura mater; 2. the tunica albuginea borrows from the tunica vaginalis the layer, which gives it that smooth, polished aspect, which we notice on its outside; 3. the free, disconnected portion of the pericardium is manifestly serous within, and fibrous without; of the two laminæ which compose it, one is reflected over the origin of the great vessels and heart which it invests, the other is continued with the fibrous tunic of these vessels, and is lost in being blended with it; 4. All the synovial membranes are so united, both to the capsules of the joints, where they exist, and to the fibrous sheaths of the tendons, that any separation is next to impossible. It is to the single membrane, the assemblage of these two laminæ distinct, in the preceding examples, that I give the name of *fibro-serous.*

202. The developement of these sorts of membranes seems often not to be manifest till in advanced life. 1. We know that the pericardium, loosely united in infancy to the fibrous centre of the diaphragm, becomes in the adult closely connected with it. 2. In the fœtus of five or six months, the albuginea alone immediately incloses the testicle; between this and the portion of peritoneum, which in the end is

destined to form its vaginal tunic, there exists a loose tissue, which permits them easily to slide over each other. 3. The dura mater and arachnoides may be easily separated in infancy.

The double stratum of the pericardium presents likewise this disposition, though less sensibly.

203. Do these various adhesions arise from the constant compression of these organs on the neighbouring parts, thus forcing them at length to unite?

Is the formation of the sero-fibrous membranes to be attributed to this mechanical cause?

If it were thus, 1. why are not all the membranes developed in the same manner? Why are some of them as well formed in the fœtus as in the adult? Why is not the pleura intimately united with the periosteum of the ribs, since there is here an habitual compression from the lungs on two surfaces, serous and fibrous? Why do not other parts beside the fibrous membranes contract with the serous a similar union, when they are in contact with them, and exposed to be compressed by motions, etc. etc.

204. These various considerations, joined to those above presented, on the pretended mechanical origin of the serous membranes, seem evidently to prove, that this manner of conceiving the operations of nature is not, in truth, that which she adopts, and that all these ideas, borrowed from physical laws, should not serve as a foundation for any physiological explication. The formation then of the fibro-serous membranes, like that of all other parts, is a result of the

organic laws, as immediate and direct as the adhesions contracted by the periosteum to the bone it covers, and to which it was not, in infancy, but very feebly attached.

205. Besides, the intimate connexion of the serous and fibrous membranes, is often essential to the functions of the part. Without it the synovial membrane plaited and rubbed in the violent motions of the joints, would soon be diseased, and would retard these motions. In general we do not find close connexions, and consequently fibro-serous membranes, except in all the organs which are not susceptible of great dilatation, as in the brain, testicle, etc., but where the organ is subject to obvious varieties of volume, as in the stomach, bladder, womb, etc., they would have hindered the different displacements, which the serous membranes must experience, as has been said, in adjusting itself to these varieties; this membrane is also every where loosely fixed by means of the cellular tissue.

§ 2. *Sero-mucous membranes.*

206. But few sero-mucous membranes exist in the animal economy; when these two simple membranes concur for the production of the same organ, they are almost always separated by an intermediate, commonly muscular, layer, as in the whole intestinal canal, the bladder, etc. The vesicula fellis however exhibits, at its lower part, the example of an immediate union. But in general the adhesion is not so intimate,

as to prevent the properties from remaining distinct. This seems to be the consequence of the mucous membranes being quite cellular without, on the side of their corion, not being able to offer to the serous membranes, points of insertion and adhesion sufficiently fixed, which in their turn, formed also of cellular tissue, can no more serve as a firm and resisting support to the corion, which would always tend to be united to it. On the contrary, the fibrous membranes of a more dense and compact tissue, offer to the two preceding surfaces a basis, in which they are intimately fixed and united, as we have seen in the fibro-serous, and as we shall soon see in the fibro-mucous membranes.

§ 3. *Fibro-mucous membranes.*

207. These sorts of membranes are observed, 1. in the ureters formed by a process of the fibrous tunic of the kidney, and the continuity of the mucous surface of the bladder; 2. in the vas deferens, evidently fibrous without and mucous within. 3. The membranous portion of the urethra presents a fibrous layer, besides the mucous which specially constitutes it. 4. Though in describing the simple mucous membranes, I have said a good deal of the pituitary membrane and of its elongations into the sinuses, it is nevertheless very probable, that it is a membrane compounded of the periosteum, there finer than elsewhere, and from the surface which forms the immediate organ of smelling. 5. It is the same, no doubt,

with the surface that lines the internal ear. 6. The Fallopian tubes seem also to be organized nearly in the same way.

208. In all these parts there is so immediate an adhesion between the mucous and fibrous surfaces, that they cannot be separated. In all, the first is the most important; on this are performed all the functions of the part; the other is but accessory to it, destined merely to furnish it a solid support, to add to its power, resistance, etc.

ARTICLE VI.

MEMBRANES NOT CLASSED.

209. There are several membranes, which cannot be referred to any of the preceding divisions, which cannot even make part of a methodical classification, either because their nature is not known, or, though well known, they exist separately, and are single of their kind.

210. Should the middle tunic of the arteries be classed among the fibrous membranes, or referred to the muscular organs? Most authors have embraced the latter opinion; but we shall be tempted, if not to reject it, at least to suspend judgment on the identity of the fibres of this tunic with the muscular, if we consider, 1. that it has not the extensibility of the muscles which are distended and flattened without breaking, when they are raised by subjacent tumors, while the arteries are soon torn in aneurismal sacks, in which they are stretched. 2. That it has not that soft-

ness of tissue, that suppleness which characterizes the fleshy fibre; that it is on the contrary stiff, hard, and even fragile, if this word could be applied to a soft body. 3. That this tunic is cut by a ligature which embraces and closely compresses the artery over its cellular coat, while from a degree of superior and even immediate constriction, the muscle is not divided, as may be seen by strangulating with a tense ligature, a portion of the intestinal tube. This phenomenon doubtless arises from the difference of tissue of which we have just spoken. 4. That the artery does not contract under the impression of the various stimulants which bring the fleshy fibre into action, during life or after death. 5. That the action of the muscle is subjected to the nervous influence; that that of the arteries is independent of it, at least, in our experiments, as many attempts have evinced, with chemical or mechanical excitants, and as I am convinced of it on dogs of a large size, by arming with metals and then bringing into contact the superior part of the mesentery, stript of the peritoneum, to expose the plexus of nerves which embraces it, with a part subjacent to this artery, or with its internal surface; or again, with the fibrous tunic immediately separated from its nervous intertexture.

211. Does the remarkable contraction of the arteries, whose caliber is effaced above the collateral branches, in the cure of some instances of aneurism, after amputations, in the umbilical vessels after birth, etc., evince a fleshy nature? Doubtless, it does not; that originates from a general modification of tonic power,

by virtue of which all the organs tend to contract, and do contract in effect, when the cause of their distension ceases to exist. The alveolus is effaced by contracting when the tooth has fallen out. The regenerated bone, which contains a loose portion, is much distended. Let this be removed, and the former diminishes rapidly.

The maxillary sinus, enormously tumified in fungi and ozenæ, resumes its ordinary diameter, and is even effaced, when the tumor is extirpated by a methodical operation, or pus is discharged. I could cite similar examples in each class of organs, but these are sufficient, because taken from parts of the greatest resistance; it is easy to imagine what happens in those of less, as in the different cavities after the evacuation of dropsical collections, in opening abscesses far from the muscles, etc.

212. So far nothing is less proved than the muscular texture of the arteries, excepting however at the origin of the aorta, and pulmonary artery. Perhaps we might with much more truth refer their middle coat to the class of fibrous membranes; and it might well happen, that their motion were but a result, not of irritability, but of the tonic powers, more decisive here than elsewhere; which implies that particular mode of vital force, which, as an author supposed, seems to hold among them the middle place between irritability and elasticity.

113. Besides, tone and irritability are absolutely of the same nature; their difference consists only in this, that the phenomena of the one are insensible, and

that those of the other are very apparent; there is no real separation between them; they succeed each other, and are confounded without being perceived. Irritability presides over the circulation of the heart; it is tone, or tonic power or force, which is its principle in the capillary system; between these two extremes, we see the circulating force gradually decrease, as the vessels divide, till it ceases to be apparent.

Irritability is the maximum, tone the minimum of organic mobility, of that mode of action, which, constantly withdrawn from the empire of the will, presides over all the phenomena of digestion, circulation, nutrition, secretion, absorption, exhalation, etc., over all those, in a word, of organic life, of the life which incessantly composes and decomposes the animal. One is exerted over the masses of animal fluids, as in the heart, stomach, bladder, and intestines; the other over their minutely divided modecules, as during absorption, nutrition, secretion, etc. It is not therefore necessary to consider these two powers separately, but rather as passing into each other by an insensible gradation. Between the muscles, the essential seat of irritability, and the glands, the organs whose tone is well marked, there are other parts, whose action holds a middle grade; as the dartos, the corpus cavernosum, nipple, etc.

From all this it follows, that in order to decide on the mode of arterial action, it is useless to dispute concerning the texture of the fibres of these ves-

sels, since nature has not exclusively attributed to the muscles this mode of action.

214. My object is not to examine here the question so much agitated by Haller, Weitbrett, Lamure, Jadelot, etc., of the pulsatory motion of the arteries. I shall only point out two experiments, which will serve those who may again be occupied in this research. The first I remarked while, with other views, I was transfusing arterial blood from one animal into the venous system of another, namely, that while the heart of the first is pushing its red blood into the vein of the second, the latter by degrees acquires the same undulatory motion, the same vibrations as denuded arteries, and whose pulsation is then, as we know, less easily distinguished than in the ordinary condition, though it is then however very perceptible. In touching another artery and this vein without looking at them, it would be very difficult to distinguish them.

This first experiment coincides with the observation of the undulating motions which the vein acquires in the varicose aneurism. I obtain also the same effect, in placing in communication over the same animal, by a bent tube, the carotid artery and jugular vein.

One of these vessels should be taken from the right and the other from the left side, to prevent the tube from being otherwise so much bent, as to present an obstacle to the blood.

The result of the second experiment is, that in transfusing into the carotid artery of one animal, in the side opposite to the heart, the blood of the jugular

vein of another, the first of these vessels loses its undulating motions, and the hand which touches it experiences nearly the same sensation as in applying it over a vein.

215. These two observations, the inverse of each other, in showing us how great is the influence of the heart over the arterial motion, in the large trunks particularly, prove that the proper force of the middle coat of the arteries affords to the circulation an active assistance, though less powerful than some authors have pretended, and that it is in the capillary system only that the influence of the vascular parietes, over the progressive motion of the blood, becomes extremely decisive and the essential cause of this movement.

Further, the first experiment is more easily executed than the second, which often does not succeed without great precautions, and in which the blood passes with difficulty from the vein into the artery.

216. To return to the middle coat of the artery, let us suspend our judgment on its classification; let us abstain equally from ranking it among the muscles or the fibrous membranes, till further experiments have acquired for us the right of pronouncing on its nature; for from this alone should be inferred, as we have said, the characters of the classes.

217. We are embarrassed by the same uncertainty when we attempt to class the internal membrane of the vessels. Its nature, yet little known, seems to deprive it of all methodical division.

This is the amount of our anatomical information respecting it.

218. This membrane, considered in a general manner, and as forming in all the vessels which it lines a continued surface, may be referred to two principal divisions; one corresponding to the black blood and lymph, the other containing the red blood. The first commences in the capillary divisions of the venous and absorbent system, lines their innumerable ramifications, their branches, and their trunks; is continued into both through the opening, into the subclavian veins, and thoracic duct, covers the right auricle and ventricle, the pulmonary artery, and all its divisions. The second has its origin in the commencement of the pulmonary veins, lines them, as well as the left auricle and ventricle, the aorta and its branches, incredibly multiplied.

219. These two surfaces, without doubt, communicate where the arteries terminate and the veins begin; there is nevertheless a clear line of distinction between them, and they each possess a mode of sensibility, having relation to the kind of blood with which they are in contact.

220. This manner of considering the internal surface of the vascular system, in showing two distinct portions, one constantly transmitting to the lungs the blood and lymph from all parts of the body, the other returning to every part the blood elaborated in the lungs, leads us to consider this organ as the general termination of the circulation, as being, with all the rest of the body, in a reciprocity of continual action; it alone corresponds, in this respect, to all the organs, since all send to it, and it sends to all the aliment of

life. Nature has here concentrated one boundary of the general circulation, and distributed the other wherever there are exhalation, secretion, and nutrition; for these are, as a last analysis, the functions which terminate the arterial circulation. Placed between these two limits of the circulation, the heart balances, and continually oscillates the blood from one to the other; and it is in relation to this middle position, that it truly deserves to be called the centre of the circulation.

In representing this function under the common idea of a circle, it may be said that one of the poles is in the lungs, the other in all parts of the system, and that the centre is in the heart.

221. The internal membrane of the vessels is observable on its outer surface, by a cellular adhesion to the middle tunic, which is sooner broken, and whose tissue yields and distends less easily than in the other organs. Sometimes this internal membrane abandons the other tunics, and borrows of the neighbouring parts a very strong envelope; thus brought towards the posterior foramen lacerum, the internal jugular interlaces its exterior fibres with the periosteum of the cranium, and sends its internal coat within the sinuses, which it lines, and with the walls of which it forms a sort of compound membrane, whose fibrous basis is borrowed from the dura mater, and which may be conceived of as the fibro-serous, fibro-mucous membranes, etc. May not the ready union between the internal coat of the vessels, and the fibrous membrane of the cranium, furnish a favourable argument for those

who believe, that the middle coat of the arteries is of the same nature as this last class of membranes?

222. The inside of the internal membrane of the vascular system is incessantly moistened with a mucous fluid, the sources of which are still unknown, and which guards it from the impression of the blood, with which it is in contact. We know the numerous valvules, with which this internal membrane is interspersed in the veins and lymphatics.

223. What is the nature of it? We have no datum respecting it; less extensible than any one of the membranes already described, it breaks by the least effort, as we see in aneurism and in ligatures on the arteries, strongly tied. Its mode of sensibility is hitherto little known. It is not the same in the portion which corresponds to the red blood, as in that in contact with the black blood, since this ceases to be an exciting agent, when it arrives at the left ventricle, which, not being able to contract, produces a delay of the blood in the lungs, and consequently in the venous system.

224. Is not this mode of sensibility a principal cause of the death which is the sudden effect of the introduction of an aëriform or other fluid into the vessels of an animal?

This experiment, very often repeated in the venous system, has not yet, I believe, been attempted in the arterial; which determined me to see if the result would be the same. I several times injected into the carotid of a dog, water of a strong blue tint, on the side of the brain; the animal died after two minutes, uttering doleful cries. The brain, examined

instantly, presented only some small capillary vessels, here and there injected and coloured with the foreign fluid, the greater part of which had doubtless passed to the heart in the course of the circulation. The same experiment, made with pure water, is not suddenly mortal.

225. I have noticed that it is almost impossible to blow air through a tube into the artery, as is done in the veins, in pushing it even with the natural course of the blood.

When an artery is cut across, it sets up, if I may thus express myself, in the part separated from the heart, an antiperistaltic motion, which sends forward the blood with a force which cannot be surmounted by the greatest efforts of expiration, and which, in spite of them, fills the mouth with this fluid.

We must necessarily adapt to the tube fixed in the artery, a syringe, by means of which the injection is strongly pushed forward. This observation confirms the necessity, already frequently proved by experiments, of tying the artery above and below its opening, in the operation for aneurism.

226. It would be quite as difficult to determine the mode of tone of the inner surface of the vascular system, as its mode of sensibility; but the existence of this property is irrevocably proved in the small vessels, where the circulation, almost independent of the heart, presents only an oscillatory motion, which is often opposed to that of the general circulation, whose direction may be changed at will, by the application of stimulants, as the experiments of Haller, Spallanza-

ni, etc., have proved, and over which the tonic powers evidently preside.

227. The functions of this membrane are to form a sort of epidermis to the artery which secures it against the impression of the blood, as that of the mucous membranes protects them against the heterogeneous substances with which they are in contact, to favour by its polish the course of this fluid, etc.

228. Besides the membranes which contribute to form the vascular system, there are several others, whose nature equally unknown, does not permit their being arranged in a general classification; such is that which lines the medullary canal of the bones, and forms by its folds the organ where the marrow is exhaled, remains, and is absorbed; such are the iris, the choroides, remarkable, one for a mode of motion which seems to make an exception to the general laws; the other for the dark humour which covers it, and whose source is unknown.

229. Finally, though perfectly known, certain membranes cannot be classed, because they exist single of their kind; such are the retina, evidently an expansion of optic nerve, the piamater, which results from a very great quantity of vessels infinitely ramified on the outer surface of the brain, and united to one another by a loose cellular tissue, which never contains fat, and becomes the seat of frequent serous infiltrations, etc.

ARTICLE VII.

OF MEMBRANES RESULTING FROM DISEASE.

230. After having embraced in a general view, the different membranes naturally developed in the organic economy, those which contribute to the functions of the animal, whether in forming part of the organs which are the seat of these functions, or in accomplishing separate uses, it now remains for us to examine the membranes accidentally resulting from a morbid state, among which we distinguish, 1. cysts, a species of membranous organs, which contain sometimes a serous fluid, as in encysted dropsies, etc., sometimes a fluid more or less altered and different from those that are natural, as in steatoma, etc. etc. 2. the pellicle which forms the cicatrix in the losses of the substance of the skin and other organs, etc. These two morbid membranes we are now to examine.

§ 1. *Of Cysts.*

231. Though the different membranous cavities of encysted dropsies, of hydatids, of steatama, of meliceris, atheroma, etc. etc., differ from each other by divers organic attributes, and though their density and thickness vary, yet they have characters enough in common to enable us to refer them to the same class: now in examining these common characters, we see them so exactly analogous to the serous membranes, that we are almost tempted, without regard to the

manner in which these membranes are unfolded, to confound them with the serous.

The following analogies may be easily conceived, if we recollect the characters which distinguish the serous membranes.

232. The analogy of conformation. Cysts form all the species of sacks without opening, inclosing the fluid which they exhale; having a smooth, polished face contiguous to this fluid, another unequal, flocculent, and continuous with the neighbouring cellular tissue, etc.

233. The analogy of structure. Always formed of a single lamina, like the serous membranes, all cysts have, like them, a cellular texture, which maceration and inflation evince.

Thus they constantly originate in the midst of the cellular organ, commonly where it is most abundant. Few blood vessels enter them; while the exhalant system is here very well marked.

The analogy of the vital properties. The sensibility imperceptible in the ordinary state, becomes very decisive in inflammation; organic sensibility always very manifest; tone which a slow and gradual contraction characterizes, after an artificial or natural evacuation of the contained fluids, etc. These are the characters of cysts; they are also, as we have seen, those of the serous membranes.

235. The analogy of the functions. Cysts are evidently the secretory, or rather the exhaling organ of the fluid they contain. Exhalation especially becomes very well marked in them, when after the evac-

uation of these fluids, the membrane is not removed, or an artificial inflammation excited in it.

Absorption is obvious in the spontaneous cure of encysted dropsies, a cure to which this function alone can contribute.

236. The analogy of diseases. Who does not know, that between the dropsy of the tunica vaginalis and the encysted dropsy of the spermatic cord, there is a striking analogy, that the curative means are the same, that the symptoms do not differ, that in both the inflammation arising from the injection of a foreign fluid, wine for instance, is of the same nature and produces the cure by a similar mechanism? Let any one open two dead bodies, each attacked with one of these two diseases, and then compare the state of the two sacks in which the fluid is collected; the aspect is exactly the same. Remove from the cyst of the meliceris, the fluid it contains; you will find but little difference between it, hydropic cysts and the serous membranes.

237. The preceding considerations lead us to establish a perfect resemblance between cysts and the serous membranes, of all whose characters they partake, and into the system of which they essentially enter. Very probably there is a connexion between them, and that when a cyst is formed, and furnishes an abundant exhalation, the exhalation of these membranes is diminished: this however is not supported by any direct proofs.

238. An essential inquiry is here presented, how cysts are developed; how a membrane which exists

not in the natural state, can originate, grow, and even in certain circumstances acquire a very considerable enlargement.

This problem is commonly solved in the following manner: at first a little fluid is collected in a cell of cellular tissue; the quantity of this fluid increases, dilates the cell in all directions, whose walls or parietes are connected with the contiguous cells, and thus increase in thickness. By little and little, the fluid, serous in dropsies, whitish and thick in steatoma, etc., augments in quantity, presses on all sides the investing pouch, enlarges it, compresses it against the contiguous organs, and gives to it the form we see. Nothing at first sight is more simple than this mechanical explanation; still nothing is less conformable to the processes of nature. The following considerations will serve to prove it.

239. 1. Cysts are analogous, in all respects, to the serous membranes; how then should they have a different mode of origin from these membranes, which are never formed, as we have seen, by the compression of the cellular tissue? 2. An origin thus mechanical, in which all the vessels, pressed against each other, must inevitably be obliterated, as is seen on the skin, becomes callous; does this agree with the vital properties, with the exhaling and absorbing function of cysts, and with their peculiar mode of inflammation? 3. If the cells applied and glued to each other, form these morbid sacks, how is it that the contiguous cellular tissue does not decrease, disappear even, when they acquire much size? 4. How is it that

their walls are not thicker at those parts of their surface, where the bony points of support facilitate still more the compression of the cellular organ? 5. If on the one hand cysts are formed by the dilatation which the fluid they inclose exerts on the cellular tissue; if on the other it is true, as we cannot doubt, that this fluid is exhaled by them, we must say that the fluid preexists in the organ which separates it from the blood. I would almost as willingly affirm, that the saliva preexists in the parotid gland, etc.

240. I think the immediate consequence of the preceding reflections is, that the common explanation of the formation of cysts is essentially contrary to the general progress of nature in its operations. How then do these sorts of sacks originate and increase? like all tumors which we see vegetate without, or manifest themselves within; for there is no difference, except that of form, as it were, between these two sorts of morbid productions. Most tumors throw out from their outer surface the fluid they secrete.

The cyst, on the contrary, exhalés this fluid from its inner surface, and preserves it in its cavity. Suppose a fungous tumor in a state of suppuration, suddenly transformed into a cavity, and the suppuration to be transported from the outer surface to the walls of this cavity, this would be a cyst.

Reciprocally, suppose a superficial cyst, whose cavity is obliterated, and whose fluid is exhaled exteriorly; you will have a suppurating tumor. Since then form alone establishes a difference between tumors and cysts, why should not the formation of the latter

be analogous to that of the former? Now has any one ever thought of attributing to compression the formation of external or internal tumors? We ought then to conceive of the production of cysts in the following manner: they begin at first by unfolding and growing in the middle of the cellular organ, by laws very analogous to those of the general growth of the parts of our bodies, and which seem to be aberrations, non-natural applications of those fundamental laws, with which we are not acquainted. When the cyst is once formed, exhalation begins to take place; at first sparingly, then more abundantly, as its progress advances. The enlargement therefore of the exhaling organ always precedes the increase of the fluid exhaled, in the same manner, every thing else being equal, as the quantity of suppuration of a tumor is in direct ratio with its size.

242. This manner of conceiving the formation of cysts, seems to me much more conformable to the laws of nature, than that previously exposed. But it still would remain to determine the precise mechanism of the origin and growth of cysts, and consequently of all tumors. Let us stop where the first causes begin. Do we know the mechanism of the natural increase of our different organs? Why should we wish to divine that of the morbid productions which are unfolded in them, which without doubt, as I have just said, pertain to the same laws? It is a great deal in the organic economy to point out analogies, to show the uniformity of an unknown phenomenon, with another, about which all the world agrees. We should have

done much for science, I think, if in all its branches we should demonstrate this principle, which already rests on so great a number of facts, namely, that nature, sparing of means, is prodigal of results; that a small number of causes every where preside over a multitude of facts, and that most of those, of which we are uncertain, belong to the same principles as many others that seem evident to us.

§ 2. *The membrane of cicatrices.*

243. It is not my object, in this place, to consider cicatrices or scars in the divers organs, to follow the phenomena of the union of the bones, muscles, and tendons. This undertaking, sketched in some points, hardly begun in most, would draw me into discussions foreign from a treatise on the membranes, in which should only be found the history of that thin pellicle, which supplies in wounds, with loss of substance, the portion of removed skin.

244. Every wound that passes its usual stages, presents between its beginning and cicatrization, the following phenomena: 1. it inflames; 2. fleshy granulations are formed on its surface; 3. it suppurates; 4. it subsides; 5. it is covered with a slender pellicle, at first red, then whitish. Let us successively examine these various stages.

245. The inflammatory period begins from the formation of the wound; it is the immediate result of the irritation of the wounding instrument, of the contact of air, of pieces of the dressing, or of other surrounding objects.

Hitherto secured from this contact, most of the parts comprised in the solution of continuity possessed only organic sensibility, but that, by virtue of which each organ is nourished, appropriates its juices, and afterwards rejects them.

But from this time these same parts, contributing to form the surface of the body, should possess the sensibility of relation, that which transmits to the brain impressions received, and which is so unfolded in the cutaneous organ. Now, I have proved above, that the effect of inflammation in all the organs, commonly called insensible, is to transform in them organic sensibility, their only property, into the sensibility of relation, of which they are destitute in the natural state. This is doubtless the first advantage of this stage of the cicatrization of wounds.

246. Another advantage of inflammation in the commencement of wounds, is to dispose them to develop fleshy granulations. In truth we notice that this developement is in general in proportion to the increase of energy and action arising from the inflammatory state.

Thus each portion of the different organs takes a new life, is penetrated with more sensibility and tone, rises to a superior temperature, and becomes the centre of a small circulating system, independent of that of the heart.

In the centre of this display of powers, the fleshy granulations spring up and increase, for the production of which the natural powers would have been insufficient.

Hence the paleness and flaccidity of these productions, when these different conditions become weak or cease.

247. This is the second period of the formation of cicatrices, in which the developement of the fleshy granulations presents the following phenomena: small reddish bodies rise here and there in form of unequal and irregularly disposed tubercles. At first more or less distant, they approximate and unite; adhesions take place between them; in this manner a thin membrane is soon formed on their superficies, every where continued of an equal extent with the wound, covering exactly, and without interruption, the parts beneath, and forming for them a new tegument.

248. This tegument is not yet the cicatrix which in the end must be infinitely more contracted; this is, as it were, a provisional epidermis, destined to guard the part during the operation which prepares and forms this cicatrix.

It differs only from the common membranes, which are smooth and every where uniform, in as much as the granulations here produce an unequal and rough surface. This unevenness of the granulations, and their apparent separation, seem at first to oppose this manner of conceiving the first state of cicatrices, but the following experiment leaves no doubt on the subject.

Make a large wound on an animal; let it run through its two first periods; then kill the animal, and remove the portion of flesh on which the granulations are formed; distend it by a rounded body applied to

the opposite side, so as to make the granulated surface quite convex from its former concave position; the tubercles are then effaced, the drawn pellicle becomes very obvious throughout, and appears like an inflamed serous membrane. Simple dissection may also demonstrate this state of the parts.

249. It hence follows, that after the union of the granulations, all access of air to the wound is excluded, and that what is commonly said of the contact of this fluid is inaccurate, and contrary to the provision of nature, who knows how, better than we do by our dressings, to protect the divided part, during the work of cicatrization.

250. When we carry our researches below this provisional pellicle, we find the granulations formed of little cells filled with a whitish, thick, as it were, lardaceous substance, and which it would be very essential to submit to analysis. This substance closes all access to foreign fluids which would tend to penetrate into the cells, which cannot be well distinguished except by maceration.

When air is blown into the cellular tissue of an animal in which a wound had been made some days before, these cells are not raised; the granulations remain the same in the midst of a general bloating of the cellular tissue. I have many times made this experiment, both during the life, and after the death of the animal.

251. What is the nature of these fleshy granulations? The following considerations prove that they essentially pertain to the cellular organ. 1. Where

this organ is the most obvious, as in the cheeks, etc., fleshy granulations more readily spring up, and wounds are more promptly cicatrized. 2. Too much stripped of cellular tissue, the skin is difficultly covered with these productions, and slowly unites to the neighbouring parts; hence the precept of husbanding this tissue in the dissection of tumors. 3. Maceration always reduces to this first basis, the surfaces of wounds, when a dead body, having wounds, is exposed to it. 4. The nature of these granulations is every where the same, whatever be the diversity of the organ which produces them, whether this be a muscle, cartilage, the skin, etc.; of which they are the expansion, the production of an organ which is found in all others; now this organ, common to all, the general basis of every organized part, is the cellular tissue.

252. Are the blood vessels of the organ elongated and developed into capillary vessels in the wound which granulations cover? I believe the redness of these productions arises less from this cause than from the passage of the blood in the exhalants and absorbents of the portion of cellular tissue which has formed them by its developement. These considerations convince me of it: 1. the cellular tissue seems to be nothing but a plexus of absorbents and exhalants; now, it is here found so gorged with blood, that of necessity this fluid must have passed into these two kinds of vessels. 2. There is a perfect analogy between the inflamed serous membranes and the red pellicle which covers, and in part forms the granulations, under the relations of colour, mode of sensibili-

ty, cellular texture, etc. The morbid absorption of the globules of blood seems chiefly to colour the inflamed serous surfaces, according to modern observations, etc. 3. This redness is merely dependent on inflammation; it ceases with it, and the cicatrix becomes white; it is therefore the morbid state, and not the organic developement of an order of vessels which are not to be obliterated, if once formed. 4. How can the system of blood vessels extend and spread out into net work, where primarily it does not exist, as in the tendons, cartilages, etc.? But nevertheless, we see reddish granulations shoot up also on these organs, etc. I however propose these reflections, without giving them an importance beyond their desert; but whatever be the influence of the sanguineous system in the formation of fleshy granulations, they are evidently owing in a great measure to the developement of the cellular organ.

253. The following events occur in the second period of the cicatrization of wounds: the cellular tissue, by virtue of the increase of vital energy developed in the first period, is raised into vesicles irregularly disposed, which are filled with a whitish substance not common, unite at their superficies, and thus form the first pellicle. But how is this first pellicle transformed into that of the cicatrix? Let us follow the steps of nature; we shall see it before it arrives at this stage, pass through those of suppuration and subsidence.

254. The stage of suppuration does not take place in the cicatrix of bones, in that of broken cartilages, of

torn muscles, etc., and in general in the union of all divided organs, without an external wound. It is requisite therefore in the first place to demonstrate what affinity is here found between these internal cicatrices and those of the outer teguments; for a uniform principle directs all the operations of nature, though they seem different in appearance.

255. When a bone is divided, the two first periods or stages of its reunion are the same as those of the exterior cicatrices. The ends inflame and are afterward covered with fleshy granulations. In the third stage, these granulations, previously united, become a sort of secretory, or rather exhaling organ which separates at first the gelatine with which it is encrusted, which gives to the callus a cartilaginous nature, then phosphate of lime, which completes the osseous disposition. In the cicatrix of the cartilages, gelatine alone is exhaled into the fleshy granulations; into that of the muscles, it is fibrine. In a word, the cellular tissue is the common basis of all the cicatrices of the interior organs, since in all, the fleshy granulations are the same; they all resemble each other by this basis. What establishes a difference between them is the matter, which is secreted and remains in the cellular tissue; this matter is in general the same as that which nourishes the organ, and which is habitually brought and carried off by the efforts of the function of nutrition. But, as each organ of a different system has its proper nutritive matter, each has its peculiar mode of union. We should know the nature of the cicatrices of the different organs, as well as that of the bones,

if the substances which nourish these organs were as well known to us as gelatine and phosphate of lime. The mode of developemont of the interior cicatrices is in general analogous to that of nutrition, or rather it is the same, with the sole difference, that the cellular tissue, rising in irregular granulations on the divided surfaces, does not furnish to the cicatrix a basis moulded on the primitive form of the organ. Hence the inequality of the callus, etc.

256. This then, in general, is what takes place in the third stage of the cicatrices of the internal organs. Exteriorly, phenomena nearly similar are manifested. The membrane which covers the granulations becomes also a sort of exhaling organ, which secretes from the blood a whitish fluid, called pus. But there is this difference, that instead of remaining in the tissue of the granulations, of penetrating and encrusting this tissue, like the phosphate of lime, and the gelatine in the bones, fibrine in the muscles, etc., it is thrown out and becomes foreign to the union; so that in the internal cicatrices, there is an exhalation, and then an encrusting of the secreted fluid; and in the external cicatrices, an exhalation, and afterward an excretion of this fluid.

257. Further, an external wound which suppurates, seems exactly to resemble the serous surfaces when they are covered, after being inflamed, with a purulent exudation. The thin pellicle which lines the fleshy granulations, is in fact, as I have observed, of the same nature as the inflamed pleura or peritoneum, that is to say, essentially cellular.

The organ secreting, or rather exhaling the pus, is in both cases membranous, and perfectly similar. The mechanism of the exhalation of pus on the preliminary membrane of the exterior cicatrices, seems to me also to have much analogy with that of the exhalation of the steatomatous fluids, which takes place in cysts.

258. Let us pass to the fourth stage of the external cicatrices, to that of their subsidence. Suppuration by little and little wastes that whitish substance which fills the cells of the granulations. Then these cells, at first much swelled up, insensibly diminish in volume; they subside; the fine pellicle which was spread over them is less stretched; at the same time the edges of the division are less tumid; they are depressed; the cavity of the wound is effaced; the bottom comes to the level of the circumference; the discharge of puss is less abundant, and is more laudable; soon its source is nearly dried up.

259. At this period of wounds, I think our dressings are in general rather injurious than useful; they affix to the divided parts, a cause of irritation, which produces a developement of vital energy, well suited to keep up the suppuration, while in the natural order, the common equilibrium of the vital powers tends to restore itself, and to stop the discharge.

Such in truth is the revolution effected in every wound whose cure follows the stages fixed by nature. 1. The vital powers are exalted at first by the inflammation, beyond the bounds which circumscribe them

in the natural condition of the divided organ; 2. they remain stationary at this degree during suppuration; 3. they gradually lessen, and at length assume their former limits at the period of subsidence. But, if you then excite them by any irritating application, lint, or medicaments, for example, you check their declension, and suppuration is supported by them. I have already several records of patients where a prompt cicatrix was the consequence of exposing wounds to the air during this last stage.

I can also affirm of two wounds made in the same dog, or in two different dogs, one being exposed near the close of a cicatrization while the other is dressed, that the first is much sooner healed than the last. I am aware that analogy is always a deceptive guide; but at least it may serve for some remote inductions.

260. The last stage of the cicatrization of wounds, is the formation of this delicate pellicle which supplies in part the place of the flesh removed; it is thus produced; suppuration has entirely exhausted the substance which was filtrated into the cells of the granulations; these cells then empty, subside, apply themselves to each other, and adhere by a mechanism analogous to that of the adhesions so frequently observed in the serous membranes; for each cavity of the cellular organ is in miniature, what the various serous sacks are on a large scale.

261. From these adhesions of the cells, divers phenomena result. All the fleshy tubercles disappear, and a uniform surface succeeds them. This surface is a

very thin membrane, because the thickness of the granulations depended, not on the cells, but on the substance which penetrated them, and which, having then disappeared by suppuration, leaves them empty.

This membrane is infinitely less extensive than the primitive pellicle which covered the granulations, because when evacuated, the cells gradually contract, by virtue of their tonic powers, nearly as when fluids are discharged from serous cavities, they contract and become incomparably less extended than during their distension. This contraction of the cells straitening their diameters in all directions, draws the edges of the division from the circumference to the centre; these approximate; the size of the wound lessens; the same granulations, which in the beginning would occupy a space of half a foot diameter, as for example in the operation for cancer, are then found condensed into a surface of one or two inches; approximating thus, their surfaces are applied to each other, they are glued together, and the membrane of the cicatrix is the result of their junction.

You see how all these fleshy points, whose developement astonished us, and which would seem amply to repair the loss of substance, are merely a pellicle, reddish so long as the lymphatics are gorged with blood, but to which the return of this fluid to its proper vessels, soon leaves a whitish colour.

262. According to this mode of origin of the membrane of external cicatrices, it is easy to conceive;

1. why they intimately adhere to the places, where they are found, and never have the laxity of the teguments; 2. why the skin converges from all the neighbouring points to cover the wound; 3. why it is wrinkled in contracting; 4. why the cicatrix is least, where the skin stretches most, as in the scrotum, the axilla, etc.; why, on the contrary, it has more extent where it yields with difficulty, as over the sternum, cranium, the great trochanter, etc.; 5. why the thickness of all these cicatrices is in an inverse proportion to their size. Indeed, as there is always the same quantity of fleshy granulations to form them, it is necessary that what they gain in one sense, they should lose in another; hence those which are very large are easily torn; 6. why they have no regular organization, and never share the functions of the cutaneous organ which they replace; why they never exhale. In truth, the agglutination of the laminæ of the cellular tissue has destroyed its exhalant system, as that of the serous membranes is annihilated by their mutual adhesion. Let us remark, that this phenomenon is a new proof that the membrane of cysts, in which exhalation is evident, is not formed, as has been said, by the mechanical or inflammatory adhesion of the laminæ of the cellular organ.

263. I have not compared these observations on cicatrices with what Fabre, Hunter, Louis, and others have written on this subject. The exposition of all the phenomena of wounds, inflamed, in suppuration, or in the state of subsiding, has not been presented.

I refer to authors who have treated this subject *ex professo:* the reader, in analyzing them, will be able to judge how far the views I offer differ from, or resemble those commonly received; and what degree of confidence they have a right to inspire in him, who pays less regard to an opinion, than to a series of connected facts.

TREATISE

ON THE ARACHNOID MEMBRANE.

SECTION FIRST.

GENERAL CONSIDERATIONS.

1. The triple covering of the brain has not always been clearly described by anatomists.

In their estimation, the arachnoides and pia mater were, for a long time, but a single membrane, a slender assemblage of two laminæ, distinct sometimes in their position, but constantly the same in their nature. This was the second meninx, or membrane of the brain.

2. In the middle of the seventeenth century, it began to be suspected that each might possess a separate existence. The Anatomical Society of Amsterdam assured themselves of the fact in 1665; Van-Horne soon after demonstrated the arachnoides separately to his pupils, which since that time has always been considered as a proper membrane. Some anatomists, Lieutaud in particular, have latterly sought to revive the opinion of the ancients, and to

reduce to two the cerebral coverings; but the following considerations seem to me irrevocably to fix opinion in this respect.

3. 1. The pia mater penetrates all the anfractuosities, whose surface it covers; the arachnoides passes without interruption from one eminence to another, and it is often seen, either separated by great intervals from the pia mater, or simply applied over it without any communication.

The basis of the brain and spinal marrow, present frequent examples of this double disposition. 2. The one reddish, entirely made up of vessels, seems intended only to offer to the trunks which enter it, a large surface, in which they may ramify without number, before they penetrate the soft substance of the brain, to which they would otherwise communicate too strong impulses; it is a cellular layer, rather than a membrane distinctly organized; a layer which unites, sustains, and interweaves the numberless branches of the exterior encephalic blood vessels. The other whitish, thin, semitransparent, destitute of this kind of vessels, seems to be a compound of exhalants which bring, and of absorbents that remove the humour, with which it is incessantly lubricated. 3. After inflammation, the first is only remarkable by its redness, an effect of the blood it contains; the second grows thick, becomes opaque and whiter, and is often covered with that viscous exudation, which is characteristic of the serous membranes in suppuration. 4. The pia mater, after having accompanied the vessels and nerves, to the trunks which send them out of the

cranium, is visibly reflected over the dura mater, which borrows from it, as I shall state, the polish which distinguishes its inner surface: the arachnoides is soon lost on the nerves, and a similar reflection is never seen. 5. In raising the arachnoides, we detach also the pia mater, which adheres on a level with the circumvolutions, and that doubtless has led to this error; but this fact no more proves the identity of the two membranes, than it establishes that of the pleura, of the pericardium, peritoneum, etc., with the cellular tissue which is under them, and which always accompanies these membranes, when they are torn from over their respective organs.

4. These cursory considerations, deduced from the exterior form, structure, and diseases of both membranes, suffice, I think, to determine between them a real line of demarcation, and to admit by consequence the separate existence of the arachnoides; but it is not much to have proved its existence, we must also determine the nature, follow the course and relations, and assign the functions of this membrane. But on all these points, the present state of anatomy presents only a chasm to be filled.

5. All the important organs, all those in habitual motion, are found covered with a serous membrane, which serves them as boundaries, separates them from the neighbouring parts, and favours their alternate expansion and contraction, by the humour which continually lubricates their smooth and polished surface. This law of conformation is universal; the lungs embraced by the pleura, the heart covered by the peri-

cardium, the stomach, intestines, liver, spleen, etc., over which the peritoneum is so largely spread, the testicle invested by the tunica vaginalis, exhibit examples of it. All these membranes possess, as I have demonstrated, the same characters of arrangement, of structure, of functions, and even of diseases. This uniformity, clearly recognized in the exterior arrangement of all the important organs, had made me long suspect, that the brain did not form an exception to the general rule, and that a covering in all respects analogous to the serous membranes of the great cavities should, in embracing it, perform the same functions in relation to it, as these membranes do in regard to their respective organs.

I think this suspicion will become a reality, if I demonstrate, in an evident manner, that, 1. the intimate nature, 2. the outward disposition, the passage and relations, 3. the offices and diseases of the arachnoides, are exactly the same as those of the serous membranes.

The object of this treatise is to develop these different propositions.

SECTION SECOND.

To determine the intimate nature of the arachnoides.

6. The intimate nature of most of our organs, almost always eludes the coarse instruments of our researches; so that in order to determine with precision what rank an unknown organ occupies among the numerous springs of our machine, we must compare it

with those whose nature, being well ascertained, leaves no doubt in the mind of the physiologist, in order to establish on analogy, what inspection and dissection cannot furnish us. This method of supplying by reasoning the defects of the senses, in our researches on organization, is particularly applicable to the arachnoides, as its extreme tenuity most generally conceals it from all our mechanical means. Now in proceeding in this way, I shall clearly prove, I think, that by its intimate nature, the arachnoides pertains to the class of serous membranes, if I establish, 1. that its sensible texture, 2. that its vital powers, 3. that its known functions, 4. and its morbid affections are the same as theirs; for similar to them, in results, the effects of organization; how can it be different in the organization itself?

§ 1. *Characters drawn from the texture.*

7. We have seen, that all the serous membranes are remarkable, 1. by a smooth, polished, shining surface, moistened by serosity, contiguous with, but never continued to the neighbouring organs; 2. by an opposite surface always adherent; 3. by the small number of their blood vessels, and the multitude of absorbents which originate from them; 4. by the essential basis of their texture, which is cellular; 5. by their transparency when detached: hence the name of diaphanous, under which M. Pinel has designated them.

8. Let us now return to the arachnoides: you will find in it all these characters, if you successively fix

your attention, 1. on its surface corresponding to the dura mater; 2. on that which adheres to the pia mater; 3. at the places where its vascular system may be most easily perceived, as at the basis of the cranium, where it is separate on both surfaces, transparent, and cannot present, as proper to itself, blood vessels pertaining to the pia mater; 4. on the remnants of the membrane exposed for some days to maceration; 5. on places where you will see it detached by a slight inflation of the pia mater which it covers. Should the tenuity of the arachnoides be opposed to the affinity established between its texture and that of the serous membranes? But who does not know that the epiploon is still thinner?

§ 2. *Characters drawn from the vital powers.*

9. Organic sensibility, manifest in the ordinary state, susceptible in inflammatory affections, of being transformed to the sensibility of relation. Tone at first not very obvious, but nevertheless characterized by a multitude of phenomena. Real extensibility, though limited: these are the vital properties of the serous membranes.

10. Such also are those which different experiments on living animals have demonstrated to me in the arachnoides. The pressure of a body, the tearing or cutting action of the scalpel, the application of various caustics, do not seem to excite in the animal any painful sensation. But the membrane is inflamed after a short exposure to the air; the contact of a body, before indifferent, becomes painful, even intoler-

able. Here, as in many other parts, the sensibility, inherent in the organ, is distributed in too feeble proportion, to become, in a natural state, an agent of vivid sensations, either agreeable or painful. This proportion must be doubled or tribled by inflammation, in order that this effect may be produced. Such in fact is the mode of distribution of the vital powers: all the classes of organs are unequally penetrated with them. Some, as the skin, muscles, etc., possess them in the highest degree.

They seem to languish and to be suppressed in others, as in the ligaments, bones, etc.

In this respect there never is an equilibrium of these powers in the economy, except in the organs of the same class. But this unequal distribution is not ordained in an immutable manner; it varies incessantly.

An habitual revolution is going on in the vital energies; nature may transport them in greater or less quantity to various parts, according to the danger that threatens them.

Then often an organ of the lowest class, in the ordinary scale of sensibility, becomes equal and even superior to any other, until the excess of life, added to its proper share, subsiding, it is restored to an equilibrium with the organs of its class.

11. The absorption performed in the arachnoides proves its tone, which is also characterized by its contraction after the evacuation of certain congestions of water, blood, etc. The prodigiously increased vol-

ume of certain hydrocephatic heads, without the rupture of this membrane, evinces its extensibility.

§ 3. *Characters drawn from the functions.*

12. The sensible uses of the arachnoides, are; 1. to secrete the brain from its first coverings, and to which, by its means, it is only contiguous; thus to form to this viscus a membranous boundary, which, interrupting, as it were, all organic communication between the brain and the neighbouring parts, insulates its own life and the important offices it accomplishes, from the proper life, and from the less essential functions of every thing that surrounds it; 2. to exhale and absorb without interruption an albuminous fluid, with which its surface is constantly moistened, which is dissipated in form of sensible vapour in animals, whose brain is laid open, particularly in cold weather; this fluid being intended to lubricate the brain, favours its motions, and prevents adhesions, which would take place without it.

13. This use, which I ascribe to the arachnoides, of being the essential organ of the alternate exhalation and absorption of the cerebral humidity, is confirmed by a multitude of considerations and facts, of which these are the principal. 1. The denuded surface of the arachnoides visibly exhales this humidity in a living animal. In fact, being entirely wiped off in any part of its extinct, it is reproduced in a few seconds. Besides, during a pretty long exposure to air, and before it inflames, this membrane remains moist; but it

would soon become dry, if the fluid, which rises in vapour, were not again supplied by the exhalation of the part. To this exhalation necessarily corresponds an absorption not only of the lymph, but of foreign fluids also.

I have opened the cranium of a dog with the trepan, after having torn and raised the thick fleshy bundles which cover its sides. The aperture was stopped, as in the experiments of Lorry, with a piece of cork, traversed by the tube of a quill, with which I injected into the cavity of the brain a slightly coloured liquid, at the temperature of the animal. The apparatus was then closed up. The animal was not drowsy; he had at first some slight convulsive motions, was then dejected and unable to move, but not completely paralytic. I killed him at the end of eight hours, but found only a very small quantity of the injected fluid collected toward the basis of the skull. The same experiment tried after death gave but a faint result, though the heat of the animal was supported by a warm bath of his own temperature. 3. In wounds of the head, effusions on the arachnoides often take place, as is proved by trepanning and the examination of dead bodies. Now, in a great number of patients treated by Desault, he never practised this operation, and yet most of them were perfectly cured; of those among these sick who had effusions, (and it is impossible that many of the number could escape them) these effusions were absorbed, since extravarated blood, which the lymphatics do not take up, always occasions accidents, inflammation, collections of matter,

etc. etc. Who does not know also, that even in the operation of trepanning, when blood is found under the dura mater, it is never evacuated but in very small quantity, notwithstanding the precaution of opening this membrane, because it is not then collected in a focus, but diffused over all the arachnoides. Now, the remaining portion, when the patient recovers, must of necessity be absorbed.

14. Agreeably to the preceding facts and considerations, it is difficult not to view the arachnoides as the essential organ of the exhalation and absorption of the brain.

Still however one difficulty remains: the dura mater, according to the common opinion, corresponds, like the arachnoides, to the cerebral cavity where this fluid is diffused; it may then, like it, furnish and take it up. But I shall soon demonstrate, that this manner of considering the dura mater is not conformable to its anatomical disposition, and that its inner surface, smooth and polished, is but a fold of the arachnoides; but this fact out of the question, which would remove all difficulty, let us reason according to the common opinion.

15. 1. The dura mater is certainly a fibrous membrane of the class of the periosteum, sclerotica, etc., of the covering of the corpus cavernosum, of the membrane albuginea, etc. But, no one of these membranes performs a function similar to this, here attributed to the dura mater. How can the latter, in all respects analogous in its organization to the other fibrous membranes, differ in the results of this organization?

2. The dura mater has every where the same structure, and yet it is only in the portion corresponding to the cerebral cavity that it seems to be an exhalant organ. Why does it not equally secrete serosity, in the orbit into which it extends, in the pituitary fossa where it passes under the gland of the same name, after leaving the arachnoides, whose superior face it lines? Why in the vertebral canal, is not its external surface often quite insulated from the neighbouring organs, as well as the inner surface, like the latter, always wet with a lymphatic dew? How is the uniformity of organization to be reconciled with this difference of functions? 3. All the serous fluids of the animal economy, which lubricate cavities, are furnished by one single membrane, and not by the concourse of several organs: how should this, altogether similar to the others in its nature, have a different mode of exhalation? 4. How can it be conceived that a fluid, essentially homogeneous, should be separated from the blood by two organs so materially different in their structure, as the dura mater and arachnoides? Is there a single example in the living economy of two organs of a different class, contributing to produce the same fluid? 5. The serosity is exhaled into the ventricles without the concurrence of the dura mater, by the arachnoides alone, which enters them, as I shall prove.

16. All these considerations have long since induced me to consider the dura mater as unconcerned in the exhalation and absorption of the brain, and to regard the arachnoides as the exclusive seat of them.

17. Let us now compare the functions of the serous membranes to those of the arachnoides, which are well proved, and we shall see them to insulate also their respective organs; 2. incessantly to exhale and absorb about them a serous humour of the same nature as that of the arachnoides, and in this respect like it essentially to contribute to the completion of the lymphatic system.

§ 4. *Characters drawn from the morbid affections.*

18. The serous membranes are remarkable, 1. because they alone, with the cellular tissue, are the seat of dropsies properly so called, or of lymphatic dropsies; 2. because after their inflammation their different faces often adhere together; 3. because then they are often thickened, lose their transparency, and become whitish; 4. because in these cases, a viscous exudation, adhering to their surface, difficult to remove, forms their suppuration.

19. A cursory examination of the arachnoides will give us all these morbid characters. 1. The sack which it forms, and especially its portion plunged into the ventricles, become the frequent seat of lymphatic collections. 2. After inflammation of the brain, Kau Boerhaave, de Haen, Boemer, etc., frequently saw the external face of the arachnoides, and the corresponding face of the dura mater, adhere together either immediately, or by means of an artificial membrane formed here, as in the pericardium, pleura, etc. When in trepanning, the dura mater is divided,

the portion of arachnoides, corresponding to the opening, is inflamed and then adheres to the cicatrix. By injecting wine under the cranium, I have attempted to produce in an animal the adhesion of this membrane, as is done in the tunica vaginalis in hydrocele; but the animal could not survive the experiment more than twenty eight hours, and the adhesion was not yet contracted. 3. I have sometimes had occasion to observe in bodies dead of wounds of the head, an opacity and thickening of the arachnoides.

It is then condensed like the pleura, by the addition of layers of a lymphatic matter. The same phenomenon, which the inspection of dead bodies every day presents, is also observed on the inner face of the dura mater, pertaining to the portion of arachnoides that lines it, but is never seen on its external face. 4. As to the viscous exudation from the inflamed arachnoides, it is confirmed by a great number of facts. This mode of suppuration is so common in wounds of the head at the Hotel Dieu, that it furnished one of the strong arguments, with which Desault combated the trepan, then always useless, since this thick, viscous layer, adhering to the external surface of the brain, could not escape through the opening. It can hardly be entirely removed by the handle of the scalpel in the dead body.

20. The numerous affinities I have just established between the arachnoides and the serous membranes in general, seem sufficient to answer the problem which I proposed above. In fact, since on the one hand the intimate nature of any organ is determined, when 1.

its texture, 2. vital properties, 3. its functions, and 4. the character which its organization impresses on its diseases, have been demonstrated; since on the other, it is clearly proved, that in these four important relations, the arachnoides is analogous to the serous membranes, I think without fear of error we may affirm, as a consequence of what has just been said, this general proposition: *The arachnoides, from its nature, belongs to the class of serous membranes.*

SECTION THIRD.

To determine the passage and form of the arachnoides over the organs which it covers.

21. We have demonstrated in the treatise on the membranes in general, that every serous surface represents a folded sack without opening, both in the organs to which it belongs, and in the parietes of the cavity where these organs are found, furnishing to their vessels a sheath which accompanies them, and never opening to permit their entrance; so that nothing is contained in the cavity it forms, and if it were possible to remove it exactly by dissection, this cavity would remain entire.

22. Now, if we compare with this conformation, that of the arachnoides, and follow its passage, it is easy to demonstrate with the scalpel, that just like these membranes, it is folded both over the brain which it embraces without containing it, and over the external face of the dura mater which it lines, and over the nerves and vessels which proceed from or enter

the brain, in such a manner that no one of these is contained in the cavity, which is filled only by its lubricating fluid.

23. In order to pursue the passage of this membrane, let us consider it, 1. over the brain, 2. over the spinal marrow, 3. over the dura mater, 4. in the ventricles; for though every where continued, it cannot be separated, yet its disposition will become more sensible in examining it at one time, in a less number of parts. From the knowledge of the different regions of this membrane, more distinct notions of its whole extent will follow.

§ 5. *Passage of the arachnoides over the brain.*

24. Viewed on the convexity of the brain, the arachnoides is there very perceptible, particularly by inflation. 1. It invests both hemispheres, and furnishes to each vein going to the superior longitudinal sinus, a sheath which is then continued on the dura mater, and embraces nearly in a similar manner the whitish corpuscles of Pachioni, which are thus without its cavity. 2. It descends on both sides over the surface of the hemispheres corresponding to the furrow which divides them, lines the corpus callosum, from which the arteries, of the same name, separate it, and furnishes to the veins of the inferior longitudinal sinus, tunics which are afterward reflected over the falx.

From the convexity of the brain, the arachnoides is carried backward and forward. This is its passage

in the first sense: 1. its portion corresponding to the hemispheres is extended over their posterior lobes which it covers, passes over the groove which separates them from the cerebellum, where it is very distinct, spreads over the superior part of that viscus, there furnishes sheaths to the veins of the strait sinus, descends over its circumference, there accompanies several vessels of the interal sinuses, and at last covers its inferior surface, where a large portion of its extent is insulated opposite to the groove which divides its two lobes. 2. As to the portion corresponding to the corpus callosum, it is extended also backward over the cerebellum, but contributes first to form round the venæ Galeni, an opening of which I shall soon speak.

26. Agreeably to what has just been said, we conceive the passage of the arachnoides over the cerebellum, the posterior lobes and convexity of the brain; but how is it carried over the basis of this viscus? thus: 1. from the superior part of the hemispheres, it goes over the anterior lobes, surrounds them, gives a sheath to the olfactory nerves, another to the optic nerves, which advances into their fibrous covering, and is reflected over it in the orbit only. 2. It embraces, by the portion descending from the corpus callosum, the pituitary trunk in form of a tunnel, whose extremity disappears in the gland of the same name, and is separated by it from the dura mater which sinks into the fossa and forms its periosteum. 3. It surrounds the carotid artery from a transparent canal, to its entrance into the brain, passes under the annular protuberance, where it is entirely insulated, as al-

so at the level of its anterior processes and grooves which limit it, and gives at the same time sheaths to the 3d, 4th, 5th, 6th, and 7th pair of nerves. 4. We see it directed over the lateral parts of the cerebellum, over the commencement of the spinal marrow, over the posterior processes of the annular protuberance; it is quite disconnected at the slope, accompanies, in these spaces, the 4th, 8th, 9th, and 10th pair, covers the vertebral, and is then continued into the vertebral canal, where we will examine it.

27. These numerous folds of the arachnoides at the basis of the cranium, are easily seen; when after exposing the brain without jarring it, it is cautiously raised before and on the sides. The different sheaths then appear larger on the side of the brain, more narrow toward the dura mater, over which they are all reflected, where it is pierced to admit the nerve or the vessel.

The optic nerve and the motor externus, are exceptions to this rule. All are loose, without adhesion to the organ which they surround, and are easily broken, particularly those of the 1st and 4th pair, which has doubtless prevented their having been hitherto described with exactness. They are almost always destitute of the pia mater, which insensibly disappears very near the brain and cerebellum.

§ 6. *Passage of the arachnoides over the spinal marrow.*

28. We have just seen the arachnoides enveloping, without containing the brain, its nerves and vessels, then being continued backward and forward over the spinal marrow.

Here it forms a sort of funnel, through which it embraces this medullary process, and descending over the numerous bundles which terminate it. In this route it is thus carried forward. 1. Free on the side of the pia mater, it is connected with it only by a small number of vascular bundles. 2 It furnishes on the sides, even with each nerve which passes out from the hole of union, a conical tunic, which accompanies it to the fibrous canal, which supplies it with the dura mater, and which, instead of entering this aperture, is reflected over the internal surface of this membrane. This reflection is rendered very apparent, by cutting this fibrous canal at its origin, which then becomes a hole stopped by the arachnoides, rendered very obvious here by its transparency. 3. Forward and backward, the arachnoides also send to the dura mater membranous sheaths, which disappear in it and contain the vessels of the pia mater, which, as well as the vertebral nerves, are without the cavity lubricated by the serosity. 4. Inferiorly the arachnoides terminates by a multitude of folds, accompanying to their egress the many fasciculi, which terminate the spinal marrow, then returning over the dura mater; and thus forming below a cul-de-sac, which hinders the serosity from infiltrating into the cellular tissue, without which we could not conceive of a dropsy of the vertebral canal.

29. This disposition of the arachnoides in the vertebral canal is rendered very perceptible in the following manner: remove from the vertebral canal, anteriorly and posteriorly, its bony portion;* lay

* In this preparation a phenomenon occurs, which clearly evinces

open also the spinal marrow, still invested with its triple covering: cut cautiously in a longitudinal direction, forward and backward, the dura mater, which will then be folded on the sides; inject air upward with a tube, between the pia mater and arachnoides; the whole of the latter will be raised, will abandon the pia mater over all the medulla spinalis, and you will thus have a tube distended with air, furnishing to each nerve and vessel a sheath, also distended, the transparent walls of which will permit you to see in the middle the spinal marrow, the pia mater, the denticulated ligament, etc. Sometimes this experiment succeeds only on the two sides, leaving the arachnoides above and under attached to the pia mater.

Nearly the same thing is done by inflation, practised in the dissection, when the peritoneum, unopened, is raised from all the organs it incloses.

§ 7. *Passage of the arachnoides over the dura mater.*

30. Agreeably to what has just been said, it is evident that the whole cerebral mass is embraced by the arachnoides, as the heart, lungs, the liver, spleen, etc., are embraced by their respective serous membranes, with this difference, that here the plaits or folds are more numerous in relation to the much greater number of nerves and vessels. It ramains for me, in order to complete the analogy, to demonstrate, that in

the contractibility of the yellow and interspinous ligaments. It is a strong retraction of the spinal column, which bends in a half-circle, when after being stripped of all it muscles, we move forward the column, resulting from all the vertebral, and consequently the anterior ligamentous apparatus.

the same manner each serous membrane, after lining its organ, is reflected over the walls of the cavity containing it; then the arachnoides, after covering the brain and its protuberancy, returns over the dura mater, the whole inner surface of which it covers.

31. We have seen the numerous sheaths which accompany the nerves and vessels, quite to their egress or entrance through the foramina of the brain and vertebral canal, then reflected and carried over the dura mater; there they all unite and form a general membrane, covering both the dura mater and its processes, such as the falx, tentorium cerebelli, which are thus without the cavity of the cranium, forming with the portion, which covers the brain, the unopened sack which I have said to be represented by the arachnoides, which presents both a cerebral and a cranial portion, as the pleura has its costal and pulmonary portions.

32. This manner of tracing the arachnoides will doubtless appear paradoxical according to the common opinion of anatomists, and from the difficulties usually experienced in separating, by dissection, this internal layer of the dura mater. But I think the following reflections will remove all doubt from the subject.

33. If we dissect in any extent the dura mater from the outer to the inner surface, raising successively its several laminæ, we observe that all are distinctly fibrous, except the last, which is cellular, without a single transparent fibre; such, in a word, we see the

arachnoides where it is disconnected on both its surfaces.

34. In the fœtus and infant, this membrane is distinct from the dura mater, to which it holds by a cellular tisssue rather loose. In beginning to dissect it, 1. over the brain, 2. along one of the sheaths of which I have spoken, 3. at the reflecting of this sheath, 4. on the dura mater, its continuity over all these points is very clearly seen, and it may be followed very far on the last. The adhesion increases with age, but its nature remains distinct: thus the serous lamina of the pericardium, very loosely united in early age, at the phrenic centre of the diaphragm, becomes in the end very closely tied to it; thus the same serous lamina and the fibrous lamina of the pericardium, though very strongly adherent on the sides, are essentially different from each other.

35. There are places where the arachnoides is very distinct from the dura mater; thus, as I have said, after having furnished a sheath to the pituitary trunk, it vanishes on the gland of the same name, while the dura mater, passing under it, lines the sella turcica. These two membranes then unite.

36. The polish of the inner surface of the dura mater evidently depends on the presence of the arachnoides. Indeed, 1. if we examine one of the fibrous ducts which the dura mater of the vertebral canal furnishes to every nerve issuing from it, on one side we see the arachnoides reflected, as I have said; if we open the duct, we perceive that it no longer exhibits a polished and glistening surface. The dura mater

therefore does not owe these characters to itself, but to the arachnoides which lines it. 2. Sometimes the arachnoides partly enters into these ducts, and is re-reflected in the middle; then they are in part smooth, in part rugous and cellular within. 3. We know the dura mater does not possess this smooth and polished aspect on the outside of the vertebral canal, though this surface is often free and without adhesion. 4. The polish observed on certain organs is always derived from the serous membrane.

Thus the heart, the lungs, the liver, etc., owe their shining and polished surface to the pericardium, pleura, and peritoneum; the inner surface of the tendinous grooves, in the capsule, described by Albinus, Junke, etc., the joints, to the membrane which I have there demonstrated; so that this exterior character of the organs always indicates a serous membrane which covers them, either in a compact manner, as the capsules of the tendons, the portion of the tunica vaginalis corresponding with the albuginea, the synovial membrane etc.; or in a lax manner, as the peritoneum, pleaura, etc. Can the dura mater alone then form an exception to this general law of the animal economy?

Let no one say that the compression produced by the motions of the brain can occasion this effect; I have shown what should be thought of this mechanical cause, and of the effects attributed to it.

37. When, after inflammation, the dura mater is remarkably thickened, the effect of a sort of membrane accidentally produced there as on the pleura, etc., we

notice this phenomenon only on the inner, and not on the outer surface: but the inflammation has been every where the same; this change then is not proper to it, but to the arachnoides which lines it.

38. The inner surface of the dura mater is evidently the seat of the exhalation of the cerebral serosity, since if exposed in a living animal, and this serosity wiped from any part of it, it is soon reproduced. Now, I think I have clearly proved above, that it is foreign from the structure of the dura mater to be the organ of this exhalation; it is the arachnoides therefore reflected over the inner surface of this membrane, which is this organ.

39. Thus every thing persuades us, that the dura mater is covered on the inside by a serous lamina coming from the arachnoides. The adhesion alone may raise some doubts, which however are easily dispelled, if we consider, that the conjunctiva adheres also to the cornea, the tunica vaginalis to the albuginea, the capsule of the tendon to its sheath, etc., and yet no one questions the existence of these membranes.

I therefore believe I may assert, as an anatomical fact well confirmed, that the arachnoides, in all respects similar to the serous membranes, has its cerebral and its cranial portion, every where contiguous with themselves, separated by the serosity, and continued only by the sheaths which contain the vessels and nerves, at points where these nerves and vessels go out from, or enter the brain.

40. Besides, when I say, in describing the passage of the arachnoides, that from the brain, it is carried

over the nerves, thence over the dura mater, etc., this expression is intended only to accommodate itself to our common mode of apprehension. No doubt it is formed at the same time over all these organs, and is developed on all in the same proportions.

If this manner of exhibiting the disposition of the arachnoides seems strange, particularly in relation to the dura mater, let us vary our expressions; let us say, it embraces the brain only, supplies the nerves and vessels with sheaths which are reflected over the dura mater, as inspection evidently proves, and are afterwards lost on this membrane, whose internal face, essentially different in its organization from the rest of its substance, is entirely similar, in this respect, to the arachnoides.

The material point is this identity of organization, between the internal surface of the dura mater and the arachnoides; an identity, evidently resulting from the facts exposed above. As to the manner of presenting the thing, it is indifferent.

Whether the dura mater changes its organization on its inside, and takes that of the arachnoides, or the latter is elongated in order to line it, is the same idea presented by the two different phrases.

§ 8. *Passage of the arachnoides into the ventricles.*

41. I have reserved for a particular article the examination of the arachnoides in the ventricles, because this fact, hitherto unknown, merits a particular attention. In truth, every anatomist has said, that the pia mater alone penetrates these cavities to line them, af-

ter giving origin to the plexus choroides. I have long suspected, that this assertion was unfounded, in conformity to the following considerations: 1. The membrane, which covers the ventricles and their several eminences, exhibits the same character, the same apparent texture, as the arachnoides, though more delicate than the latter; it has the smooth and polished aspect of it; it covers the blood vessels, without seeming to contain them in its tissue, which is, excepting in the plexus choroides, essentially different from that of the pia mater; 2. a lymphatic dew is incessantly exhaled and absorbed from its surface; 3. it suffers frequent dropsies; 4. its inflammation is often followed by mucous exudations similar to those of the arachnoides and the other serous membranes, a character by no means belonging to the pia mater.

42. These first considerations led me to suppose the ventricles to be lined, like the exterior of the brain, with a sort of membrane in form of a sack without opening, similar to all the other serous membranes, and that its tenuity eluded our dissections. Another reflection confirmed me in this idea: the dropsies of the ventricles often exist separately, the water of the exterior sack of the arachnoides not being augmented: now, if the membrane in the ventricles were not different from the pia mater, the water there effused would soon flow outward, by filtrating through the processes of this last membrane, which, from the basis of the cranium, ascends into the ventricles through numerous apertures of communication.

It is requisite therefore, that these openings be clos-

ed by a membrane on the side of the ventricles: I consequently examined the place where these outer productions of the pia mater are confounded with the plexus choroides, and I saw in fact a very fine web passing over them, thus preventing their being contained in the cerebral cavities, and then losing itself in the neighbouring eminences, such as the thalami nervorum opticorum, the corpora striata, pedes hippocampi, etc.

43. I no longer doubted, 1. that what had been taken in the ventricles for a production of the pia mater, was a genuine serous membrane, lining the walls of these cavities, and then spreading round the choroid plexuses, really situated without the pouch; 2. that there was thus on the outside and inside an organ exhaling serosity, serving it as a temporary reservoir, and then transmitting it to the circulating current; 3. that if dissection could not, step by step, conduct us hither, analogy at least would supply its defect in an obvious manner. But one question remains to be solved: has this membrane an insulated existence, or is it a continuation of the arachnoides, whose nature it partakes? Inspection decides this question.

44. I have said, that after lining the corpus callosum, the arachnoides descends over the cerebellum; but there extending, it dips into the ventricles through an oval opening, situated between these two parts. It here embraces at first on all sides the venæ Galeni, and their numerous banches, which, each receiving a tunic, are not contained in the opening, although they traverse it in all directions. It then extends under these veins

between the pineal gland and the tubercula quadrigemina, and at last terminates in the third ventricle, forming a distinct canal.

45. In order to find this canal the cranium must be cautiously sawed, and the falx very lightly raised, lest the jarring be communicated to the tentorium cerebelli, to the venæ Galeni, and to the portion of arachnoides coming from the corpus callosum, and this portion be torn and at the same time the aperture be destroyed; which happens in most cases where these attentions are neglected. The brain being laid open, each hemisphere is raised behind, separating it a little outwardly. The venæ Galeni then appear passing out from a canal which embraces them, and whose oval orifice is very visible.

46. Sometimes however the edges of the orifice so encircle the veins, that it cannot be distinguished, and at first sight there might seem to be a continuity. Then slip a probe along these vessels from behind forward; when it has entered a small distance, turn it quite round; it will divide the adhesions, and the aperture will become very perceptible.

47. To be assured that this opening leads to the third ventricle, a grooved probe must be introduced, passed under the venæ Galeni, and gently pushed forward; it penetrates without difficulty. We then lift up the corpus callosum and the arch with three pillars, so as to leave in its place the choroid curtain; we then cut on the probe, and see, in its whole passage, that the membrane, smooth and polished, has not been torn to admit the instrument. A degree of resistance is some-

times felt, which cannot be surmounted; this arises from the veins, which come to disgorge their contents into those of Galen. Crossing every way in the canal, they render it, as it were, reticulated, and arrest the instrument. It is then necessary to withdraw it, and in order to demonstrate the communication, to pour some mercury into the exterior hole, which from the inclined position of the head, passes immediately into the third ventricle.

Air blown in also enters the third ventricle, and thence into the lateral, through the anterior openings, exactly described by Vicq-d'Azyr. If we raise the arch with three pillars, before inflation, and lay open the choroid curtain, it rises every time the air is thrown forward.

48. The inner orifice of this duct of communication, concealed in the inferior part of this choroid curtain, is not seen without difficulty, and even if a fluid is injected into the third ventricle, it does not pass out exteriorly, because, without doubt, its edges collapse on themselves, and oppose it.

49. It seems therefore, agreeably to what has just been said, 1. that the membrane of the ventricles, analogous in its appearance and nature to the arachnoides, is a production of it, and that the medium of communication between them is the canal, of which I have spoken; 2. that this production, still more thin than the arachnoides already so slender, is at first expanded over the third ventricle; 3. descends backward through the calamus scriptorius, into the fourth, which it covers, and where it closes the apertures, through

which the pia mater penetrates to sustain the vessels; 4. goes forward through the two holes of communication of the lateral ventricles, holes not well seen except by beginning the dissection of the brain from its basis, lines these two ventricles and their eminences; 5. is reflected over the plexus choroides, closes the whole length of the concavity of the hippocampi, the communication between these cavities and the exterior, a communication through which the piamater is introduced to be continued with the plexus choroides, which is chiefly produced by the extension of this same membrane, which penetrates between the opening described above, and the arch with three pillars.

50. After what has been just said, it is evident, that the serous membrane lining the ventricles, is to the arachnoides, what that of the cavity of the epiploon is to the peritoneum, and that the most perfect analogy exists between the opening I have described, and that situated under the gall bladder, leading to this cavity.

51. From this we easily comprehend a phenomenon, which sometimes occurs in opening dead bodies. The ventricles are much distended, their cavity doubled, or even tripled, and yet containing but little serosity, while there is much of it at the basis of the skull. The water could only escape through the opening I have mentioned; the corpse being laid on the back, and the head turned over.

I remark on this subject, that a certain sign of the dilatation of the ventricles, which is not always easily distinguished in a brain not laid open, is the diminution of the anfractuosities then pushed outward, and

the less projection of the circumvolutions, so that the cerebral surface is nearly even in all its points. This sign has never deceived me.

52. After all which has been said in this article, I think it would be difficult to doubt the analogy of the arachnoides with the serous membranes, from its conformation. Like them, we see it spreading both over the organ to which it belongs, and the cavity which invests it, forming a sack without opening, in which the serosity is collected, embracing the nerves and vessels, and forming their sheaths, which prevent their being contained in this sack, at last passing down into the ventricles, and there forming a great appendage, similar to that which the peritoneum sends under the stomach and colon, before the pancreas and duodenum, etc.

53. We may now then, without fear of error, solve the problem, proposed at the beginning of this article, on the conformation of the arachnoides, by confirming the following proposition: *The arachnoides, by its external appearance and its course, belongs to the class of serous membranes.*

54. But we have seen above, that from its intimate nature, the arachnoides ought also to be ranked in the same class of membranes; we can then pronounce with certainty, that *the arachnoides, in all respects, is a membrane essentially serous.*

SECTION FOURTH.

GENERAL CONCLUSION.

55. The multiplied facts, exposed in this memoir, enable us to present in this place some general views, as conclusions from them. They relate to the diseases and functions of the arachnoides.

56. In the inflammation of the brain and its membranes, it seems that the arachnoides performs a principal part.

This membrane occasions this inflammation to be referred to that of the serous or diaphanous membranes. If the dura mater partakes of these affections, it is on account of the inner layer that lines it. An experiment renders this fact very clear.

Denude the dura mater of an animal, over a pretty large extent of its external surface; cut it in such a manner as to expose to the air its internal surface; the latter will be much sooner inflamed than the former; for it will much sooner become red, and particularly more promptly sensible to the impression of external irritants, which is imperceptible to the animal, in the first moments of the operation. In the inflammations of the brain, the dura mater also is readily inflamed, but the primitive seat of the mischief seems to be in the arachnoides.

Is it not moreover known that it is rarely, except on the internal surface of the dura mater which is lined by it, as also on the surface of the brain, that the

purulent exudation and morbid membranes are observed, which are the result of these inflammations?

It further appears from the observation of diseases, that the inflammation of the fibrous membranes, such as the dura mater, is much slower in its progress, than that of the serous membranes. The inflammation of the periosteum, compared with that of the pleura, is a proof of it.

57. Though the dropsies of the arachnoides exhibit phenomena analogous to those of the other serous membranes, and may therefore be regarded as a great reservoir accidentally filled with serosity, between the exhalants which continue their functions, and the absorbents which cease to act, yet some differences are met with sufficiently notable. 1. In general dropsy, wherein the whole lymphatic system is struck with atony, the whole cellular tissue infiltrated, all the cavities filled, this nearly always eludes the general law. 2. The dropsy of the arachnoides is more peculiar to the infant and the fœtus; that of the peritoneum, of the pleura, tunica vaginalis, and of the pericardium, are more frequently observed among adults. Could this arise, as it respects the arachnoides, from the concentration of vital energy in the head, in the first stage of existence, an epoch to which nature, obliged simultaneously to perfect all the organs of the life of relation which exist there, seems to neglect the other parts, to double the labour of nutrition in this? We know in general, that the earliest periods of existence are more than all others subject to diseases of the head. 3. A circumstance doubtless also

influences the different dropsies of the arachnoides; namely, that there are by no means so many absorbent vessels, of those at least that are visible in our preparations, in the head as every where else, as the researches of modern Italian, English, and German anatomists have proved.

58. I do not here speak of the use of the arachnoides in separating the brain from the neighbouring organs, and of thus rendering its life independent of theirs: I have elsewhere considered this general function of the serous membranes.

A

TREATISE

ON THE

SYNOVIAL MEMBRANE.

1. No part of the physiology of the bones abounds more in hypotheses and less in discoveries, than the history of the synovial system.

Many discussions and few facts; a long series of assumed principles; a brief assemblage of proofs: this is nearly the analysis of all the hitherto known works on this subject. The notions already received throw but little light on those yet to be acquired.

It is, in some sort, necessary to inspect things in a new point of view: this I am about to attempt in the following treatise, whose object is to make known, 1. the mode by which the synovia is transmitted to the articular surfaces. 2. The general distribution of the synovial membrane, an essential agent in this transmission. 3. The particular dispositions of this membrane, in the several articulations.

ARTICLE I.

Of the mechanism, by which the synovia is transmitted to the articulations.

2. Every fluid, different from the blood, cannot be separated from it, to be afterward transmitted to any organ, except by one of the three following modes: 1. by secretion, a function characterized by the existence of a gland between the blood vessels which bring the blood to it, and the excretory vessels which carry off the secreted fluid. 2. By exhalation, distinguished from the first function by the absence of this intermediate gland, and by the immediate continuity of the blood vessel and the exhaling duct.* 3. By transudation, a phenomenon purely physical, almost always cadaverous, rarely observed during life; the simple transmission of a fluid through the pores of an organ, toward which it is mechanically determined.

Let us examine which of these three modes is that chosen by nature, for depositing the synovia on the articular surfaces.

§ 1. *Is the synovia transmitted by secretion to the articular surfaces?*

3. We are indebted to Clopton Havers for the system, which places in the glands the sources of the

* This distinction between secretion and exhalation extends only to characters, perceptible to the eye. It is however probable, that there exists in the glands an immediate communication between the blood vessel and excreting duct; so that the difference of the two functions seems to relate merely to the more numerous folds, and the more complicated intermixture of the two vessels, for secretion; to their shorter passage and more direct course, for exhalation.

synovia. Casserius, Dulaurens, Severin, and Fab. ab Aquapendente, had obscurely designated these organs in the articulations. Cowper also thought he had perceived them, but Havers made them the particular object of his researches, described them in the different joints, and distinguished them into two classes, one principal, the other accessory: he assigned to them characters so obvious, that according to him, they cannot be mistaken.

4. Reddish, spongy points or eminences *(pelotons)* formed of membranes reflected on themselves, situated sometimes without and sometimes within the joints, always so disposed as to be secured against a too strong compression, pouring through ducts in form of fringes the fluid they secrete; such are the characters traced by Havers, and which all anatomists admire after him, and whose accuracy Winslow, Haller, Monro, Albinus, and Bertin have particularly consecrated in their works.

5. Some anatomists however of the present century have thrown doubts over these glandular bodies. Lieutaud confounds them with the fatty cellular tissue: Desault did not at all distinguish them from it. Every thing confirmed me in the same opinion, which a great many considerations seem indubitably to establish.

These considerations I proceed to lay open in succession.

6. These reddish balls or points are met with only in certain articulations. There are several in which their existence rests merely on supposition.

Most of the mucous capsules of the tendons certainly present not one of them, though Havers, Albinus, Junke, and M. Fourcroy admit them in all, founded no doubt on analogy, and not on inspection; yet the synovia is separated equally in these two cases, and lubricates the surfaces of the joints and tendinous sheaths. This secretion is therefore independent of glandular action.

7. If we examine the synovial glands more clearly marked, like that of the cotyloid cavity, we there discover no trace of that parenchyma unknown in its nature, but remarkable for its structure, which in general composes the glands, and which, distinguishing them from every other part, forms their true organic character.

8. No excretory duct can be demonstrated in these organs. Those admitted by Havers, in form of a fringe, are imaginary. Bertin himself has acknowledged this fact, though he attributed to these bodies a glandular structure. The transudation of fluids injected through arteries near the articulation, no more proves the existence of these ducts, than it does in the cavity of the serous membranes, where it equally takes place, and where however it is well proved, that no gland pours forth the albuminous humour which habitually lubricates this cavity.

9. Inflation completely resolves these adipose eminences, into cellular tissue. Maceration produces the same effect. When a boiling, for sometime continued and gradually raised, has extracted all the fat from them, there remains only a mass of cells, col-

lapsed on one another, resembling those of the ordinary cellular tissue.

10. The glandular character is manifested in some pathological cases, by a particular tumefaction and induration, of which the organs, other than the glands, such as the muscles, tendons, etc., never offer an example. The liver, the kidneys, the salivary organs, all the sensible glands, are remarkable for this.

Such even is the validity of this character, that it serves to point out glands whose tenuity, in the sound state, conceals them from our view.

For example, the existence of the cryptæ of the stomach, of the urethra, and several other mucous membranes, was first founded on the analogy of the other membranes of this class, but principally on the accidental developement which these cryptæ, or small glands, acquire in certain diseases.

On the contrary, the pretended synovial glands never exhibit to the observer a similar developement. In the diseases of the joints, a common obstruction seems always to identify them with the neighbouring cellular tissue.

They have not, like the other glands, diseases separate from those of this tissue, doubtless because they have not a proper vitality; because, being only productions of the contiguous cellular tissue, they partake of its nature, its properties, and ought of consequence to participate in all the conditions of the cellular tissue, while this in its turn must immediately receive the influence of their diseases.

11. These considerations form, I think, an amount

of data sufficient to solve the problem proposed above, in establishing the following general proposition : *The synovia is not transmitted by secretion, to the articular surfaces.*

Let us pass to the second mode of transmission pointed out by authors.

§ 2. *Is the synovia transmitted by transudation to the articular surfaces?*

12. It was an opinion anciently received, that the marrow of the long bones oozed out through the pores of their extremities and through those of the cartilages which terminate them in order to lubricate the articular surfaces. Havers revived this idea, forgotten at the time he wrote, united this source of the synovia to that he had placed in the glands, and thus formed of this fluid a mixture, compounded of two fluids differently transmitted to the articulation. Most of those who followed him, adopted his opinion on this subject. Those even, like Desault, who rejected the existence of the articular glands, and by that also the secretion of the synovia, cannot admit its transudation, by reason of the following observations. 1. A long bone, divested of its soft parts, and exposed to the air, permits a greasy exudation to escape through the pores of its cartilages, which continues till all the medullary substance is completely exhausted. The mechanical compression of the cartilaginous extremity of a long bone, instantly produces the same phenomenon. These facts, evident in the dead bone, are they also real in the living? Various considerations which I am about to expose, lead me to believe the contrary.

13. The vital energy, whose effect is to impress on all the organs it animates, a degree of tone sufficient to resist the access of the fluids, leaves, in its absence, the fibres of the same organs in a state of laxity, which every where renders them permeable.

Thus transudation is no longer considered but as a phenomenon purely cadaveric, which being here transformed into a vital phenomenon would present a manifest exception to the laws of nature, particularly characterized by simplicity and uniformity.

14. The oily exudation takes place in the above experiment, not only through the pores of the cartilages, but also through all the surface of the bone; so that in reasoning from what is here observed in the dead body, it is evident, that during life, the entire bone should be, as it were, immersed in an atmosphere of synovia; a consequence, which, disproved by the most simple inspection, demonstrates the fallacy of the principle from which it results.

15. The articulations of the cartilages of the larynx are lubricated, like those of the bones, by the synovial fluid; yet here any transudation of marrow is impossible, since it does not exist in the substance of the cartilages.

16. The marrow is almost always untouched in the diseases which, affecting the articulations, alter the humour that lubricates them. Reciprocally the synovia suffers no change in diseases of the inside of the bones, whose special influence is exerted on the medullary organ. An experiment confirmed me in this

fact, which the various diseases of the bones also demonstrate. I opened on the sides, two long bones of one of the hind legs of a dog, so as to introduce into it a red hot probe, which, having been several times repeated, completely destroyed the two medullary systems.

Necrosis soon followed this experiment previously made by Troja, but which presented to me a result, which escaped his notice; that was, the soundness of the articulation which united the two gangrened bones. This phenomenon, confirmed by several experiments, dissipates every doubt as to the non-transudation of the marrow to form synovia. Should not this fluid in fact have ceased to moisten the joint after the destruction of the medullary organ, if this transudation did really take place during life?

17. Desault, in order to explain the manner in which the synovia is separated from the blood, added to this pretended transudation of the marrow an oozing, furnished by all the parts contained in the joint, such as the capsular and interarticular ligaments, the internal fat, the cartilages, etc. One comparison will be sufficient to estimate this hypothesis.

What would be said of a system in which, in order to explain the production of the serous fluid of the abdomen, one should place its source in the liver, the spleen, the intestines, and in general in all the organs of this cavity?

It would doubtless be answered, that a fluid, the same in its nature, could not be supplied by parts so different in structure, and that it is much easier to find its single source in a single membrane which invests

all the gastric viscera. The application is exact and the analogy complete, as to the articular cavity.

18. From what has been above stated, I think we may conclude, without fear of error, that, *The synovia is not transmitted by transudation to the articular surfaces.*

I pass to the last mode suggested for the separation of the synovia.

§ 3. *Is the synovia transmitted by exhalation to the articular surfaces?*

19. The solution of the two preceding problems seems naturally to bring us to the inquiry here proposed. In fact, there are two data, on the certainty of which, I think, we may rely: 1. secretion, exhalation, and transudation are the only means by which a fluid, differing from the blood, can be transmitted to an organ; 2. secretion and transudation are foreign to the transmission of the synovia. Now, from these two certain data, may we not infer this consequence also certain: exhalation is the mode by which the synovia is conveyed to the articulations? But let us add to these negative proofs considerations, which establish this proposition positively.

20. The most striking relations or affinities are observed between the synovia and the fluid which lubricates the walls of the serous membranes. 1. The relation of composition. These two fluids are essentially albuminous; albumen predominates in both, although a little different in the two. Havers had already pointed out this analogy; he knew that these two fluids are

coagulable, by alkohol, the acids, and caloric, without knowing the principle to which this property is owing. 2. The relation of functions. Both are destined to lubricate surfaces of much motion, to lessen the consequent frictions, and to prevent fatal adhesions. Both are in the same state, on their respective surfaces. A dew is diffused over these surfaces, which is soon taken up. 3. The relation of diseases. Inflammation dries up the source of both, and produces adhesions more common in the serous membranes, more rare in the joints, where they produce anchylosis. Both are subject to morbid additions, which a common word designates, that of dropsy. 4. The relation of absorption. The lymphatic system is the route through which both enter the circulation, after having remained a sufficient time on their respective surfaces.

21. Do not these various affinities which, with some small differences of composition, so visibly connect the synovia with the humour of the serous membranes, lead us to this very plain conclusion, to wit, that these two fluids, being analogous in all these respects, should they not also be similar in the manner of their separation from the mass of blood? Now, it is a point of physiology at this time generally acknowledged, that the fluid of the serous membranes is supplied by exhalation; we are accordingly clearly conducted from one induction to another, even to this, which answers the question above propounded: *The synovia is transmitted by exhalation, to the articular surfaces.*

This precise, strict induction drawn from palpable and constant facts, will become, I think, a demonstrated truth, if, to the analogies previously established, we add that of the membranous organ, the essential seat of the exhalation of the synovia. This membrane will engage our attention in the following article.

ARTICLE II.

OF THE SYNOVIAL MEMBRANE CONSIDERED IN GENERAL.

22. We have seen in the treatise on the membranes in general, all the great cavities lined with a serous membrane, which forms, by its folds, a sort of sack without opening, which embraces both the organs and the parietes of the cavity.

There exists in all the moveable articulations, a membrane exactly analogous, whose uses are the same, whose nature is not different, and which I call *synovial*, because its parietes incessantly exhale and absorb the synovia.

§ 1. *Exterior organization of the synovial membrane.*

23. We should accordingly consider every synovial membrane, as an unopened sack, spread over the organs of the joint, over the diarthrodial cartilages; on the internal face of the lateral and capsular ligaments, over the whole of the interarticular ligaments when they exist, over the jutting bundles of fat in certain articular cavities, etc. From this membrane these various organs borrow the smooth, polished, shining aspect which characterizes them in these cav-

ities, and which they have not any where else. Thus in exactly dissecting the gastric organs, the peritoneum might be raised, its sack remaining untouched; in the same way we might conceive the possibility of detaching and insulating this membrane, without the intimate adhesions which it contracts in some places. All the parts it embraces are without the articular cavity, though projecting into this cavity; as the lungs are found on the outside of the sack formed by the pleura, the liver without the peritoneal pouch, etc. etc.

24. The synovial membrane is found in all the moveable articulations, the greatest number of which have only this and some lateral ligaments.

What is commonly called fibrous capsule, is seen only about certain articular surfaces. The connexions of the humerus, of the femur, and of some other bones, whose ends are joined by enarthrosis, are the only instances of it.

In these joints we meet with two teguments quite distinct: one fibrous is exterior, and disposed in form of a sack, open above and below, embracing by these two large openings the surfaces of the two bones, and are blended about them, with the periosteum, whose fibres are interwoven with those of this tunic. The other cellular, which is the synovial membrane, lines the inside of the first, leaves it when near the two diarthrodial cartilages, and is reflected over them instead of uniting with the periosteum. M. Boyer has pointed out this disposition.

25. In all the ginglymoid articulations, as in those

of the elbow, knee, phalanges of the hand, of the foot, etc. etc., the fibrous capsule is absolutely wanting. The fibres, instead of being extended and interwoven into membranes, are collected into bundles more or less thick, which form the lateral ligaments; hence we find only the inner lamina of the enarthrodial articulations, that is, the synovial membrane, which no more contracts here any adhesion with the periosteum, but is reflected over the cartilages. At this reflection it may be detached before, and thus exhibit an external organization, wholly different from that which the idea of an articular capsule first presents to the mind. This disposition is very easily perceived by the least dissection, in the knee, behind the tendon of the cruralis, and the interior ligament of the rotula, at the elbow under the tendon of the triceps, at the phalanges under that of the extensor, etc.

All the arthrodiæ have likewise a similar organization, as will be seen in the following article; so that we may be assured, that the fibrous capsules exist only in a small number of joints, most of them having only synovial sacks or pouches, which are expanded and reflected over the bony surfaces without being attached round them, as all authors have described it.

26. Last year, when I published a memoir on the synovial membrane, I was unacquainted with this remarkable difference of the articulations. I have confirmed it, this summer, by a great number of dissections.

Some anatomists were on the track of this discovery, when they observed that divers capsules seemed

to be wholly formed of cellular tissue. It is in truth the texture of the synovial membrane, which essentially differs in this respect, from the fibrous capsules. Continue the name capsule, if you please, for all the articulations; but then we must of necessity attribute to it different ideas. Compare, for instance, the fibrous capsule of the femur, to the synovial capsule of the knee; you will find in the first case: 1. a cylindrical sack, with two large openings for the osseous extremities, and several small ones for the vessels; 2. a fibrous net-work, like that of the tendons, and aponeuroses; 3. a mode of sensibility, similar to that of these organs; 4. the use of strongly retaining the articulated bones in their place, which have only this string or bond to strengthen their union. In the second you will observe: 1. a sack without opening; 2. a cellular structure, precisely like that of the serous membranes; 3. a sensibility of the same nature as theirs; 4. the simple function of secreting and containing the synovia, the bones being tied together by strong ligaments.

27. The existence of the synovial membrane in all the articulations where it is single, is placed beyond doubt by the simplest inspection. In those, wherein it is united to a fibrous capsule, it is also very well distinguished in different places. Thus in the femur we dissect it on the interarticular ligament, on the fatty protuberance of the cotyloid cavity, on the neck of the bone, at places where it leaves the fibrous capsule, to be reflected over the cartilages, etc.; but its adhesion to these cartilages, and to the inner face of

the capsule, might raise some doubts as to its disposition in form of a closed sack, which we have attributed to it; it is therefore important to offer some considerations, suited to dissipate these doubts.

28. 1. However firm may be the adhesions of the synovial membrane, they can be destroyed without solution of continuity, by a slow, careful dissection, begun where the membrane is reflected from the cartilage over the capsule; long continued maceration likewise permits it to be removed in fragments. 2. After certain inflammations, this membrane becomes thick and opaque, and is thus distinguished from all the contiguous organs, from those even to which it most closely adheres. 3. The mucous bags, bursæ mucosæ, of the tendons, are quite as adherent, as the synovial membrane, to the cartilages of their sheath and to this sheath itself; yet every one acknowledges their insulated existence. 4. There are articulations in the fibrous capsule in which the fibres, being separated, leave intervals between them, through which the synovia would escape, if the synovial membrane did not line them.

When air is thrown into the joint, we see it rise through these spaces, and present a texture altogether different from that of the capsule.

Bertin made this observation, but he supposed these pellicles were insulated, and did not perceive that they were dependent on the continuity of the membrane, extending over the whole articulation. 5. We observed in the article on the serous membranes, that the smooth and polished aspect which the surface

of the organs of the cavities presents, is always given them by these membranes, and that they never receive it from their own proper structure: now we shall see, that the synovial membrane has the same structure as the serous; it appears therefore, that where the articular organs present this character, they receive it from the synovial membrane, though it cannot be so well distinguished on these organs, as where it is free. Besides, the articulations, evidently deprived of this membrane, do not present this smooth and polished aspect.

Such are the surfaces of the symphisis pubis, of the sacro-iliac symphisis which are, though contiguous, unequal, rugous, etc. We have also proved, that this organic form never originates from compression.

29. If we add to these various considerations, the analogy of the synovia with the serous fluid, an analogy, which confirms that existing between the two sorts of organs whence these fluids flow, we shall be easily convinced, I think, that notwithstanding the adhesion of the synovial membrane in divers points, it should be considered in a manner exactly analogous to that of the serous membranes, that is, as a real sack without any opening, every where continuous, and spread over all the organs of the articulation. Further, have we not seen the fibro-serous membranes present similar adhesions, though the separate existence of the two layers, of which they are composed, is generally admitted?

30. Agreeably to our idea of the synovial membrane, it is easy to imagine how certain organs trav-

erse the articulation, without the synovia's escaping through the aperture which receives them, or through that which transmits them exteriorly. The synovial membrane, being then bent round these organs, forms for them a sheath, which separates them from the fluid, and insulates them from the joint. Thus the tendon of the biceps is more inclosed in the articulation of the arm with the omoplate, than the umbilical vein, urachus, etc., in the peritoneal cavity. With the least attention, we succeed in separting it from the portion of membrane which forms its sheath.

31. The preceding considerations lead us also to find a perfect identity between the mucous capsules of the tendons and the synovial bags, or bursæ. In the preceding example, these two sorts of membranes are evidently continuous; for the capsule of the bicipital groove is of the same nature with that of the tendons, which have one of them insulated, like the flexors for example.

§ 2. *Interior organization of the synovial membrane.*

32. We have just seen, that by its exterior conformation, the synovial essentially pertains to the class of the serous membranes; it ought also to be ranked there by its internal organization. This organization is all cellular, as dissection, inflation, and above all, masceration prove.

The cyst or sack forming ganglions, is clearly nothing but a production of the cellular organ; now we know this sack exhales and contains a fluid similar to the synovia. Wherever the synovial membrane is

free, it is connected exteriorly with this organ, and is confounded with it, in a manner so immediate, that in successively removing its different layers, we see them gradually condensed, and at last closely united between them to form it. Just as in the serous membranes, no fibre is there seen distinct. It becomes transparent, when it is exactly separated on both sides, which is easily done in the knee, in a very great extent.

33. I will not recur to the various proofs which have confirmed the cellular structure of the serous membranes; all these proofs are likewise applicable to the synovial which seems to be a mere net-work of absorbents and exhalants. According to this, it is easy to conceive what are the fatty, reddish bundles, disseminated about the articulations. They perform, in regard to this membrane, the functions of the abundant cellular tissue, which envelopes the peritoneum, pleura, etc. etc. Here the blood vessels are divided without end before they arrive at the membrane, where their ramifications, successively decreasing, terminate at last in the exhalants.

34. If a remarkable redness sometimes distinguishes these balls or eminences from the cellular tissue, it is because the vessels are more concentrated and approximated in them.

For example, in the hip joint, whose synovial membrane, almost every where adherent, does not correspond except in the slope of the cotyloid cavity, to the cellular tissue, nature has here crowded together almost all the arterial ramifications which furnish the synovia; hence the reddish tint of the cellular pack-

et or fasciculus here found. On the contrary, in the knee, where much cellular tissue surrounds the whole external face of the synovial sack, the vessels, more disseminated, leave this tissue of the same colour as that of the external face of the serous membranes, etc. This redness of some pretended synovial glands, the only character which distinguishes them, is rather accidental; it no more indicates their glandular nature, than it proves it in the pia mater, where it depends on the same cause.

§ 3. *Vital powers of the synovial membrane.*

35. Organic sensibility is the sole property of the synovial membranes in the ordinary state, as many trials on living animals have convinced me, wherein these surfaces were denuded and irritated by divers agents. But the increase of life, produced by inflammation, in exalting this sensibility, transforms it into that of relation; as is observed, 1. in wounds where these membranes are exposed to the contact of air; 2. in the prolonged irritation which they suffer from foreign substances, accidentally developed in the articulation; 3. in the different diseases of the articular surfaces, etc.

36. This mode of sensibility of the synovial membranes serves to confirm what I have already decided above; to wit, that most of the articulations, the ginglymoid especially, are destitute of fibrous capsules. Indeed, I have shown that the capsules, as well as the lateral ligaments, have a mode of relative sensibility, which is developed in the sound state, by the pulling they

experience. Hence if a ginglymoid articulation, in an animal, is laid open, and all the contiguous organs removed, excepting the synovial membrane and lateral ligaments, and the joint is then twisted, the animal gives signs of the sharpest pain. But if we then divide the ligaments, leaving the synovial only, the twisting is no longer felt, and we may now distend and even tear the joint with impunity. There was therefore no fibrous capsule, joined to the synovial.

37. This experiment, easily repeated in the anterior or posterior limbs, may there serve to ascertain the articulations, where there is a synovial membrane only, and those having the addition of a fibrous capsule.

The latter, being of the same texture as the lateral ligaments, produce the same pains when pulled, as are experienced in experiments made on the joints, invested with these capsules.

38. The evacuation of the articular dropsies of the knee, after which the synovial membrane collapses, and the habitual absorption of these membranes, prove their tonic powers, which otherwise have nothing particular in their developement.

§ 4. *Functions of the synovial membrane.*

39. The synovial membrane seems absolutely foreign to the solidity of the articulation ; the fibrous capsules and lateral ligaments alone accomplish this purpose. The smooth surface which the articular extremities borrow from this membrane, favours their movements; it may even in this respect assist the

muscular action; thus the portions of synovial membrane in the knee, behind the crural muscle, in the elbow, under the triceps, in the phalanges, under the flexors, etc., perform, in respect to these muscles, the functions of the bursæ mucosæ; they are to their tendons what the cellular sack, separating it from the crural arch etc., is, to that of the proas and iliac muscles.

40. The principal use of the membrane in question relates to the synovia; it exhales from many orifices the fluid, which it retains for some time, and is then returned into the circulation by absorption. Its walls are accordingly the seat of the exhalation, as the kidney for example is that of the secretion of urine.

The reservoir of the exhaled fluid is the closed sack which it forms, as the bladder is that of the urine.

The excretory vessels of this same fluid are the absorbents, which eject it into the mass of blood, as the urethra throws out the urine from the bladder. In these different respects, there is more analogy between secretion and exhalation than at first appears.

41. The phenomena of the retention of the synovia in this membranous receptacle, relate to itself, or to the articular surfaces. The first consist in a peculiar, but unknown alteration, which it undergoes between the exhalant and absorbent systems. The second contribute to facilitate the articular motions.

The unctuous and slippery coating, which the surfaces receive from the synovia, is singularly suited to this purpose.

ARTICLE III.

42. After having pointed out, generally, the disposition of the synovial membrane, it is necessary to describe its passage over the various articulations, where it is distributed. The general form above mentioned remains always the same; it is ever a sack without opening, embracing the several articular organs. But according as these organs are more or less numerous, nearer or more distant, etc., it offers varieties, which we are about to examine.

It will however be useful in the first place briefly to trace the classification of the articulations, that we may arrange our descriptions more methodically.

43. In order to express each articulation, I premise that I shall make use of an expression, compounded of the name of the bones which contribute to its formation; thus, instead of this expression; the articulation of the humerus with the omoplate, I shall say, the *scapulo-humeral* articulation. This will prevent circumlocution, and the new nomenclature, which, in several other parts, burdens anatomical language with words, will here serve to relieve it. I shall here employ some of the bases adopted by M. Chaussier.

§ 1. *General division of the articulations.*

44. The articulations may be regarded in a double point of view: 1. in the order of their position, in the head, trunk, and limbs; 2. agreeably to the numerous classifications to which they have been reduced. To me the second method seems preferable, because

in comparing together the articulations whose structure is analogous, it will enable us to present, beside the description of their synovial membrane, some views on the general relations of their functions.

45. All the articulations are referred to two general classes. Mobility is the character of the first, immobility that of the second.

The former pertains to the locomotive bones of the limbs and trunk, to certain bones which conduce to the internal functions, such as the jaws, ribs, etc. The latter occurs particularly in the connexions of bones which form cavities, destined to protect and secure some essential organs. The head and pelvis are examples of them.

46. The class of moveable articulations includes two genera, whose characters are drawn from the motions, in some instances easily executed in all directions, in others limited to a certain number. These are the articulations: 1. moveable and vague, 2. moveable and limited.

47. In the genus of moveable and vague articulations there are three species, whose character is deduced from the bony surfaces which form them, and which are either contiguous and free, or contiguous and close together, or continuous by an intermedial substance between them. 1. Mobility is the attribute of the first species, always placed on the superior part of the limbs, whence it derives from this situation a double advantage. On the one hand far distant from the part of the limb immediately exposed to the action of exterior bodies, it more easily es-

capes those luxations, to which its want of solidity exposes it. On the other hand, it can impress on the limb some general motions in place of those of the lower joints, whose solidity is incompatible with unrestrained movements. This is the articulation not only of the bones which form it, but also of the limb, the whole of which it moves. The enarthrosis of the femur and humerus is an example of this disposition. 2. The second species is remarkable for its solidity; it also occurs in those parts of the limb where the effort of exterior agents is immediately exerted, such as the tarsus, metatarsus, the carpus, metacarpus, etc. 3. Mobility and solidity united characterize the third, which is found in the organs intended, like the vertebræ, for the double purpose of guarding an important part, and of contributing to locomotion.

48. To the genus of moveable and limited articulations, are referred two species characterized also by the bony surfaces which are, 1. unequal, with an eminence and depression reciprocally received by each other; 2. uniform and in one single direction. One destined for flexion and extension, occupying the middle of the limbs, occurs in the elbow, knee, fingers, etc. The other, better suited to lateral rotation, is seen in the forearm, and second vertebra.

49. The class of immoveable articulations includes three genera, characterized by the mode of union of the long surfaces, which are, 1. in juxtaposition; 2. indented; 3. implanted.

The first genus occurs where the mechanism alone of the parts is nearly sufficient to secure the solidity of

the bones. Thus the maxillary bones wedge in between the ossa malarum, the ossa unguis, the ethmoides, the ossa palati, the vomer, and the coronal bone, are more supported by the general mechanism of the face, than by the articulating ligaments which unite them to one another, and which would permit an easy dislocation.

The second genus is found where the influence of general mechanism being less, it is requisite the solidity of the articulation should supply its place; thus the two parietal bones are fixed, between them, and by the mechanism of the cranium, all the bones of which form an arch by their mutual indentation.

Finally, the third genus is observed where the mechanism of the part having no influence, the solidity of the bone is wholly owing to the articulation. The teeth are an example of this arrangement.

50. The following table presents all the different articulations in a single view.

ARTICULATIONS.	Classes.	Genera.	Species.
	I. Moveable;	I. Moveable and vague;	I. with surfaces contiguous and free . . [*Enarthrosis*]
			II. with surfaces contiguous and compact . [*Arthrodia.*]
			III. with surfaces continuous. [*Amphiarthrosis.*]
		II. Moveable and limited;	I. with surfaces unequal. [*Angular ginglymus.*]
			II. with surfaces uniform. [*Lateral ginglymus.*]
	II. Immoveable;		I. with surfaces in juxtapositioon. [*Harmonia.*]
			II. with surfaces indented . . . . [*Suture.*]
			III. with surfaces implanted . . [*Gomphosis.*]

51. Several articulations, which I have just presented, evidently ought not to occupy our attention, since they have no synovial membrane. The second class is in this respect foreign from our purpose, as well as the third species of the first genus of the first class: we shall only therefore treat of the enarthroses, of the arthrodiæ, and of the two species of ginglymus.

§ 2. *Moveable and vague articulations, with free, unconnected surfaces.* [Enarthrosis.]

52. This species comprehends two varieties. In the first, there is, 1. a movement of opposition in all directions, backward and forward, inward and outward, etc.; a movement of circumduction, a union of all

these; 3. a movement of rotation on the axis of the bone. The humerus and femur are the only examples of this variety.

The other variety differs only from this in not having the rotatory motion on the axis; all the others pertaining to it. I rank here the articulations of the clavicle, jaw, etc.

1st. VARIETY.

53. The humerus and the femur are very similar in their superior articulations. Both perform in all directions very extensive motions, being however essentially different, and which has not been examined in a general manner; their rotation and circumduction are in a ratio exactly inverse. Rotation in the femur is very extensive, and circumduction or sling movement, pretty limited; the humerus on the contrary possesses very sensible circumductive motions, but only a slight rotation. The mechanical reason and advantages of this disposition, are readily apprehended.

54. In the femur, the length of the neck, which is the lever of rotation, produces great extent in this motion, which makes amends for the want of pronation and supination in the leg, so that any rotation of the foot is a movement of the whole limb. In the humerus on the contrary, the very short neck, bringing the axis of the bone nearer the centre of motion, restrains the rotation, which is less necessary because of that of the forearm; the inward or outward motion of

the hand is therefore never communicated, except by a part of the limb.

55. With regard to circumduction, or the sling motion, the length of the neck of the femur is an obstacle to it.

In effect let us remark, that this motion is the more easily performed when executed by a rectilinear lever, because then the axis of the motion is the same as the axis of the lever; that on the contrary, if the lever is angular, the motion becomes so much the more difficult, because the axis of the motion is no longer that of the lever, and in general it may be said that the difficulty of the motion is in direct proportion to the distance of these two axes. This being admitted, let us observe, that the axis of the circumductive motion of the femur is evidently a strait line, obliquely directed from the head to the condyles, and consequently removed upward from the axis of the bone, through the whole neck. Now, conformably to what has just been said, it is evident, that the difficulty of circumduction will be in direct proportion to the length of the neck, and consequently pretty great.

In the humerus, on the contrary, the neck being very short, the axis of the bone and that of the motion are almost confounded.

Hence the facility and extent of the circumduction. We might accurately decide the relation of these movements by this proportion: the circumduction of the humerus is to that of the femur, as the length of the neck of the humerus is to the length of the neck

of the femur; which leads us to determine how far the circumduction of the femur is more difficult than that of the humerus; to ascertain this, it is sufficient to know the excess of length of the neck of the first bone over that of the second. Borelli, Keil, Sauvage, Hamberger, etc., have expressed this by mathematical formulæ, which to me seem useless.

56. We readily percieve the advantages of this very extensive circumduction of the superior extremities destined to seize objects, and of the limits prescribed by nature to that of the inferior extremities, intended for standing and locomotion.

57. We now come to the structure of the two joints of the humerus and femur; they have each a strong fibrous capsule continued to the periosteum from which it originates, no lateral ligaments, but much cellular tissue round them; their synovial membranes are very distinct: see how they influence the humerus.

58. *The scapulo-humeral articulation.* 1. It lines the glenoid cavity; 2. descends all along the capsule, whose inner face it covers, where dissection from without inward demonstrates it; 3. is reflected over the head of the humerus, over the neck of this bone, at its internal part, over the tendons of the infra-spinatus, supra-spinatus, and subscapularis; it is remarkable on this last tendon, which, visibly piercing the capsule, would be found in the articulation, without this reflexion of the synovial membrane.

This disposition is rendered visible, by dividing the capsule and it transversely, between this tendon

and the biceps; these two membranes are then seen, one fibrous, the other cellular, to separate and pass, the first behind, the second before the tendon. 4. This descends into the bicipital groove, lines it to the place where the tendon comes out, is reflected over it, rises, forming its sheath, which embraces it in the same manner we observe it in the capsules of the tendinous sheaths, is then continued with the portion we have seen line the glenoid cavity, and in this manner it forms the unopened sack, represented by all this class of membranes. Besides, it is easy to be assured of its reflection over the tendon of the biceps, in the bicipital groove, both by dissection and by the infusion of any fluid, mercury for instance, which is then supported by the cul-de-sac, formed by this reflection.

59. *The ischio-femoral articulation.* At the femur, the synovial membrane, 1. lines the cotyloid cavity, in which it becomes very manifest over the fatty ball or projection which its depression incloses, either by dissection, or by inflating this fatty tissue; 2. is displayed over the pad, and descends all along the inner face of the capsule, to which it communicates its characteristic polish; 3. leaves it and is reflected downward over the neck of the femur, where a very lax tissue evidently separates it from the bone, which is here deprived of its periosteum; 4. is continued from the neck, over the head of the femur, investing its cartilage, and contracting with it intimate adhesions; 5. quits this, and extending along the inter-articular ligament, forms its sheath, very easily separated by dissection, which, in the same manner as that of the tendon of the biceps,

prevents this ligament from being inclosed in the articulation, and is thence continued over the cotyloid cavity, whence we have supposed it to originate.

60. Conformably to this it is evident, that the two preceding articulations are enveloped, each by a membranous sack of a double stratum; one fibrous, arising from the periosteum of the two articulated bones, is confounded with this membrane, whose nature is the same as its own; the other serous, purely cellular, is reflected over these bones without being attached to them, and is absolutely foreign to the periosteum. Thus the serous layer of the pericardium is reflected over the heart, while the fibrous is elongated and confounded with the external tunic of the great vessels.

61. Some authors have pretended, that there was a communication between the capsule of the tendon of the supra-spinatus and the articulation of the humerus. I have not been able to meet with this disposition; but I saw, three years ago, in a dead body brought into my amphitheatre, a remarkable fact.

This subject had an old luxation of the left arm which was dissected. The head of the bone was lodged in the hollow of the axilla, surrounded by an artificial capsule, whose aspect on its inner surface was the same as that of the synovial membrane, which was wet with a fluid analogous to that of this membrane, and which, like most cysts, was probably formed by a condensation, or union, of the cells of the cellular tissue. The cavity of this capsule communicated with that of the articulation by the laceration of

the orbicular ligament and the synovial membrane. This rent was situated inferiorly, and the synovia could thus pass alternately from one to the other cavity. The articular cavity was not at all contracted, or narrowed, as several authors have affirmed, by the swelling of the cartilage.

I could not learn the date of this luxation, which must have been of long standing, since this cyst had had time to form.

This fact proves farther, both the possibility of reducing old luxations of the humerus, since the cavity remained in its natural state; and the necessity of making, in this reduction, extensive motions to destroy the attachments of the accidental cyst at the circumference of the head of the bone.

2d. VARIETY.

62. The second variety of the enarthroses differs from the preceding, in as much as the former execute no rotatory movement. To conceive the reason of it, let us remark, that in all joints, the axis of the moveable head is the same, as that of the bone; thus, at the sternal extremity of the clavicle, at the metacarpal extremity of the first phalanges, the articular surface is crossed by the axis of the bone itself. On the contrary, in the femur and humerus, this axis makes an angle with that of the bony head; now it is evident, that rotation cannot be performed except in this last case; because it is the only one in which there is a lever of motion, a lever which represents this axis of the bony head, and of the neck which supports it;

such is, for instance, in the thigh, the axis of the neck, and of the head of the femur: the extent of the rotation is in a direct ratio to the length of this lever; when it diminishes, rotation becomes less sensible, as in the humerus; when it disappears, rotation must consequently cease, as in the articulations of which we speak.

63. I place in this second variety, the articulations of the clavicle with the sternum, of the wrist, of the first phalanges, of the feet and hands, with the bones of the metatarsus and metacarpus, and of the jaw with the os temporis. In truth, rotation excepted, all these articulations perform the same movements, as those specially designated under the name of enarthroses. Look at the disposition or course of their synovial membranes.

64. *The temporo-maxillary articulation.* The union of the temporal bone with the jaw should not be considered under the relation of the articulating ligaments, as is commonly done. This species of articulation is visibly destitute of a fibrous capsule. What authors have pointed out under this name is nothing but a double synovial membrane, which seems to be continuous, but which is really very distinct. One of these membranes is spread, 1. over the fossa of the temporal bone and its transverse apophysis; 2. over the superior face of the inter-articular ligament; 3. forms in passing from one to the other, the superior part of what is commonly called the capsule. The other embraces, 1. the condyle, backward more than forward; 2. the lower surface of the articular liga-

ment; 3. constitutes, in its passage from the first to the second, the inferior part of the pretended capsule.

65. There are here then two contiguous sacks, which do not communicate with each other, except in cases where this intermediate substance is perforated, which are separated in the ordinary state, by this substance or this ligament, which is not continuous with this double membrane, but is solely supported by the manner in which it is embraced by each. Its circumference is not, as has been said, united to the capsule; because a fibrous body is never blended and identified with a serous membrane. Each synovial sack, when it reaches this circumference, is spread over the ligament, and is then extended over both surfaces, so that, except for the adhesion it contracts, we conceive the possibility of removing it, without penetrating into the two cavities. Besides, the articular ligament is almost always fixed outwardly by a fibrous process, by means of which it is continued, between the two membranes, with the periosteum of the outer side of the condyle.

The rest of the circumference is continued also before, between the two points where they are reflected, with the aponeurotic fibres of the external pterygoid muscle, is free in the other directions, and correspondent only with the cellular tissue and the two lateral ligaments.

Dissection will readily convince us of this anatomical arrangement of the parts, in showing the reflection of each membrane, both over the middle ligament, and the articular surfaces where it has no continuity with the periosteum, like the fibrous capsules.

66. *The sterno-clavicular articulation.* This articulation has two synovial bags or sacks, but no fibrous capsule. The anterior and posterior ligaments sometimes form before the inter-clavicular, by their continuity, a similar covering; but they are often distinct and separate. Then we see, in their intervals, the synovial membranes which rise in small vesicles, particularly when the joint is strongly shaken in different directions.

Moreover, the superior synovial membrane is always observed alone on the outside, separated by the fatty tissue of the costo-clavicular ligament. Hence the reason why the inter-articular ligament, meeting there no other fibrous substance than the periosteum, is attached to it, while anteriorly, posteriorly, and inwardly, it is fixed to the ligaments; which confirms a remark I expounded above, to wit, that no serous membrane ever serves for the insertion of ligaments, tendons, etc., but that the fibrous membranes always answer this purpose.

67. Of the two synovial membranes of this articulation, the first embraces the articular face of the sternum, and the sternal face of the clavicular ligament, and in passing from one to the other lines the superior part of the anterior and posterior ligaments; the neighbouring fatty tissue of the costo-clavicular is sometimes visible, as I have just said, between the two first and the inter-clavicular. The second is spread over the sternal extremity of the clavicle, over the lower part of the anterior and posterior ligaments, over the clavicular face of the inter-articular ligament,

which is thus truly without the two cavities, though concurring to divide them. The reflection above and below the two synovial membranes is perceptible over it, so that it is very obviously not with them, but with the ligaments and periosteum that it is continued. Further, these two membranes are remarkable for their habitual dryness in the dead body.

68. *The radio-carpal articulation.* The articulation of the wrist presents very distinctly one synovial membrane, which, 1. braces down the scaphoid, semilunar, and pyramidal bones, is easily distinguished where these bones are united by an intermedial tissue, particularly between the scaphoides and semilunare; 2. lines, anteriorly, posteriorly, and over the sides, the anterior, posterior, and lateral ligaments; 3. is reflected upward over the end of the radius and the carpal face of the inter-articular ligament of the cubit. To see this membrane clearly in the part corresponding to the ligaments, it is necessary to split them in some point of their adhesion; the double stratum is then separated without difficulty.

69. *The metacarpo-phalangian articulation.* This articulation, common in the hand, to each of the fingers and bones of the metacarpus, has great analogy with that of the foot; it will therefore be sufficient, I think, to describe here their synovial membrane, to have an idea of that corresponding to it in the foot. As in the clavicle, it has no fibrous capsule. The exterior organs which strengthen it, are, on the back part, the tendon of the extensors, forward a fibrous layer in a transverse direction, over which the flexor tendons

pass, on each side a strong ligament. The synovial membrane applies to all these organs, and to the articulating surfaces.

1. It lines the portion of the extensor tendon corresponding to the articulation, quite unattached above, strongly adherent below; in turning this tendon over the convexity of the finger, it becomes very apparent; we see it, not originating from the periosteum, like the fibrous capsules, but loosely united to the cellular tissue, and spreading itself over the articulating face of the metacarpal bone, in such a manner that in dissecting it at this fold we can trace it, without injuring it, to the cartilages, where it becomes strongly adherent. 2. It passes over the superior articulating face of the first phalanx; 3. then mounts, while investing the lateral ligaments and the anterior fibrous lamina, over the inferior articulating face of the metacarpal bone; but before it comes here, it is to be remarked, that it is expanded in a small space over the anterior face of this bone, which thus contributes to enlarge the articulating surfaces before, and also to favour the flexion of the first phalanx.

70. *The carpo-metacarpal articulation of the thumb.* The metacarpal bone of the thumb is remarkable for the mobility, which particularly distinguishes it from the corresponding metatarsal bone, which is characterized by great solidity of articulation. The use of one in taking hold of objects, and that of the other in standing, explain this difference. The articulation of the first belongs to the class which now engages our attention. It seems to be provided with a fi-

brous capsule, originating from the periosteum of the trapezium and of the metacarpal bone, but having fibres less compact than those of the true enarthroses, and leaving to be seen in the intervals of these fibres portions of the synovial membrane, which embraces the two articulating surfaces, is displayed more largely forward than backward, and then covers all the inside of the fibrous capsule, from which however some fatty bundles separate it.

§ 3. *Moveable and vague articulations, with compact surfaces.* [Arthrodiæ.]

71. Several of the articulations, which I have referred to the second variety of the preceding species, pertain to this in most anatomical books, in that of M. Boyer, for instance; they have however evidently more affinity with the enarthroses, since they have all their movements, except rotation, while the arthrodia is only characterized by a slipping or sliding motion which it performs, and to which the compact disposition of the articulating surfaces reduces it. Besides, it would doubtless be better to make of them an intermediate species between enarthrosis and arthrodia.

72. I have long thought that the best division of the moveable articulations would be that, which, being founded entirely on their motions, would indicate these motions decreasing successively from enarthrosis the most extensive, to arthrodia the most limited, and consequently the nearest to the immoveable articulations. Agreeably to this idea, the following would nearly be the division:

Classes.	Motions.	Examples.
I.	1. Opposition in all directions. 2. Circumduction. 3. Rotation on the axis. 4. Sliding.	Scapulo-humeral and Ischio-femoral Articulations.
II.	1. Opposition in all directions. 2. Circumduction. 3. Sliding.	Sterno-clavicular, Temporo-maxillary, etc. etc. Articulations.
III.	1. Opposition in two directions. 2. Sliding.	Humero-cubital, Femoro-tibial, etc. etc. Articulations.
IV.	Sliding.	Calcario-astragalian, Peroneo-tibial, etc. Articulations.

73. In this series, methodically distributed, we see nature combine all the motions in some articulations, then gradually lessen them, in approximating the immoveable joints, and at length meeting them, in a mere sliding, which is often scarcely perceptible.

There is again an intermediate grade of motion even between sliding and immobility, it is the articulation of the symphisis pubis, in one part of which the surfaces are contiguous as in the moveable articulations, in another the surfaces are continued, as in the immoveable. This articulation and that of the humerus, may form in the series the two extremes of mobility.

74. I have not adopted this division, because by placing in a new order descriptions likewise new, the attention bestowed on the former is often diverted from that due to the latter.

75. Let us return to our arthrodial articulations; I divide them like the enarthroses, into two varieties

each having for its general character the compact disposition of surfaces and the single motion of sliding or slipping, but distinguished, the one because this motion is apparent, the other because it is ordinarily insensible. In the first, I rank the articulations, 1. of the first verbebra with the occipital bone; 2. of the vertebræ between themselves, by their articular laminæ; 3. of the carpus; 4. of the metacarpus; 5. of the different bones of the tarsus; 6. of those of the metatarsus.

To the second pertain the articulations of the extremity, 1. humeral of the clavicle; 2. sternal of the ribs; 3. superior of the perone.

1st. VARIETY.

76. *The occipito-altoid articulation.* The synovial sack of this articulation embraces, 1. the condyles of the occipital, with a small portion of this bone anteriorly; 2. the corresponding vertebral face; 3. in passing from one to the other, it lines before a fibrous bunch descending from the occipital, and backward and outward, much cellular tissue, within the extremity of the transverse ligament, which without it would be in the articulation, a part of the lateral ligament of the odontoid apophysis, and some adipose bundles which project into the articulation, and were formerly taken for synovial glands. This membrane is very visible in the places of its reflexion, and in those of the adipose bundles of the cellular tissue. No fibrous capsule is here met with.

77. *The axoido-altoid articulation.* This artic-

ulation, more lax than any of the articulating apophyses, having no fibrous capsule, exhibits a very distinct synovial membrane, whose passage is this: 1. it is spread over the articulating face of the atlas, whose cartilage it not only lines, but also the bony circumference; 2. we see it descend over the face of the second vertebra, which it inverts in the same manner, in lining anteriorly a fibrous fasciculus or bundle descending from the atlas, behind much cellular tissue, within the ligaments of the interior of the vertebral canal, without the vertebral artery which, in its passage in this place, borrows from it a serous tunic, analogous in miniature to what we see on a large scale in the aorta, which the pericardium, pleura, and peritoneum embrace, in places where it passes level with them, and which, without this disposition, would be bathed by the synovia of the joint. Authors have designated this synovial membrane, under the name of capsule, as well as most of those which have already been explained; but it is easy to see that its nature is altogether cellular, and that it is not at all attached, as has been said, about the articulating surfaces, but that it is here reflected without any continuity with the periosteum.

78. *The vertebral articulations.* The synovial membrane has here nothing peculiar; it embraces the two articulating faces, in passing from one to the other lines the contiguous organs, and is in all, particularly in the neck and loins, insulated outwardly from the ligamentous capsules.

79. *The costo-vertebral articulation.* A very

weak synovial membrane embraces on the one hand the face of the transverse apophysis; on the other that of the rib, and facilitates their reciprocal slipping. A great deal of cellular tissue surrounds it.

80. *The carpal and metacarpal articulation.* The lateral articulation of the scaphoides with the semilunare, of this with the pyramidale, communicates in the articulation of the first with the second row, and this general articulation communicates itself with the particular articulations of the trapezium and trapezoides, of this last and the os magnum, of the os magnum and the unciforme, of these various bones with the corresponding bones of the metacarpus, and even of these bones of the metacarpus among themselves. A common synovial membrane is spread in form of an unopened sack over all these articulating surfaces, and over the inner face of the multiplied ligaments which unite them.

By carefully raising several of these ligaments, we may perceive it, because it often adheres to them merely by a loose texture.

It is also distinguished by cutting all of them with it, over the convexity of the carpus, and then turning over all these small bones; its inner face is then very well seen on the opposite side; it is also apparent on the neck of the head of the great bone, to which it serves as a periosteum.

Authors have designated this membrane under the name of capsule; they have described it separately for each bone, saying it existed only forward and backward, and that it was wanting at the points of

communication; but it is evidently continued throughout.

The two articulations of the third with the fourth metacarpal bone, have no communication between themselves, and the anterior insulated has always a synovial membrane proper to it. The pisiforme and pyramidale have also their proper membrane.

81. *The calcareo-astragalian articulation.* The astragalus and os calcis are united each by a double insulated surface. Hence two articulations; the one posterior, is only embraced by a thin synovial membrane which, after having lined the cartilage of the astragalus, it descends, covering anteriorly a ligament between the two articulations, behind much fat which separates it from the tendo Achillis, the outside and inside of the lateral ligaments, with which it contracts intimate adhesions, it is then spread over the face of the os calcis, covering not only the upper part, but also the circumference, particularly outwardly.

The second joint of the astragalus and os calcis, is common likewise to the scaphoides. Its synovial membrane, 1. covers the face of this last bone; 2. passes over an adipose bundle and a ligamentous bunch, which separate it from the face of the os calcis, and where it is very manifest; 3. is continued over the latter bone; 4. comes over the cartilaginous surface of the astragalus, corresponding to the two preceding; 5. returns to the scaphoides, lining the ligaments which connect it with the astragalus. Authors have called these two membranes capsules, and said they were attached about the articulating surfac-

es, although there is here neither reflexion nor insertion.

82. *The calcareo-cuboid articulation.* The synovial sack of this articulation is extended over the two articular surfaces, then passing from one to the other, lines, above ligamentous fibres from which it is easily separated, and whose interstices often render it visible, lines the filamentous ligament below, within a mass of ligamentous fibres and of cellular tissue between the os calcis, cuboides, and scaphoides, without the synovial sheath of the tendon of the peronæus longus muscle, in such a manner, that here two membranes of the same nature are found contiguous to each other.

83. *The cuneo-scaphoid articulation.* Three faces entirely cut in the scaphoides, receive the three superior faces of the cuneïform bones. In this general articulation, the partial articulations of the cuneïform bones open.

A common synovial membrane is spread here, as in the carpus, over all the articulating surfaces, and over the ligaments which unite them.

84. *The cuneo-cuboid articulation.* The third cuneïform bone only contributes with the cuboides to this articulation, which a very delicate synovial capsule, invested above and below by ligamentous fibres, embraces, in the rest of its extent by cellular tissue.

85. *The metatarsal articulations.* The first metatarsal bone has an insulated articulation with the first cuneïform ; ligamentous fibres above and below

strengthen this articulation; on the inside there are processes of the tendon of the tibialis anticus.

The synovial sack is spread over all these parts, as well as over the articulating surfaces; exteriorly it corresponds only to the cellular tissue.

86. The synovial capsule of the joint of the second bone, is a mere production of that of the joint of the scaphoides with the cuneïform bones, a production which spreads, 1. over the corresponding faces of the second cuneïform and second metatarsal bones; 2. over the inferior and external faces of the first cuneïform and lateral face of the same second metatarsal bone, forming below a cul-de-sac, which retains the synovia; 3. over the superior and inferior ligaments, being the means of union of all these articulations.

87. An insulated synovial membrane is carried over the joint of the third metatarsal with the third cuneïform bone, is extended over the contiguous faces of the second and third metatarsal bones, of the third and fourth, and forms in these two places culs-de-sac.

88. The two last metatarsal bones have for their articulations with the cuboides, and for that of their contiguous lateral surfaces, a single synovial membrane, forming between them a cul-de-sac, displayed over all the articulating surfaces, and easy to be distinguished in several places, between the fibrous ligaments which surround it.

2d. VARIETY.

89. The articulations, of which we are about to speak, terminate, as it were, the class of moveable articulations; they lead to the immoveable, by a transition almost insensible; a transition however, to which the symphysis pubis is still intermediate, as I said above.

90. *The acromio-clavicular articulation.* Two oblique faces compose this articulation, destitute of fibrous capsule, fortified above by accessory fibres, every where else surrounded by cellular tissue, and having a thin, delicate synovial capsule, reflected over the articulating surfaces and over the neighbouring parts. This capsule is double when there is an inter-articular ligament.

91. *The peroneo-tibial articulation.* We find here but one synovial capsule, sufficiently visible, covered anteriorly and posteriorly by ligamentous bunches, from which the cellular tissue separates it, corresponding in all its other points to this tissue.

92. *The sterno-costal articulation.* No articulation exhibits the synovial membrane more obscurely than this.

We can scarcely distinguish some folds passing from the faces of the sternum to those of the ribs; little or perhaps no synovia is found here; the surfaces are unequal and rough. If this membrane exists here, this articulation is truly the transition from those which are provided with it, to those which nature has deprived of it.

§ 4. *Moveable and limited articulations, with unequal surfaces.* [Angular Ginglymus.]

93. To this species are referred the articulations, 1. of the knee, 2. of the elbow, 3. of the instep, 4. of the phalanges between themselves, 5. of the head of the ribs with the body of the vertebræ. All these, like the preceding, are destitute of fibrous capsules, invested merely by ligamentous bunches, and covered by a simple synovial membrane, being reflected from the organs which surround the joint over the articulating surfaces, and not being inserted, as authors have said, round these surfaces. As most of these joints are very considerable, that of the knee in particular, we there distinguish, with the greatest facility, this general anatomical disposition hitherto unknown.

94. *The femoro-tibial articulation.* In order to describe the synovial membrane of this joint with exactness, the most obvious of those of the organic economy, let us suppose it to originate from any one point, and thence trace it over the numerous organs which encircle and fortify the joint. 1. By turning back from above the femoral muscle, we see it unattached through a large space, covered only by much adipose substance, no where adherent, but reflected before the condyles, in such a manner that it may be dissected to the edge of the cartilage, though it is reflected much farther, chiefly over the sides where it extends over a pretty long track without the condyles, loosely united to them. 2. Thence it descends, intimately adhering to the rotula in the middle, loosely

united on the sides to the aponeurotic expansitions which terminate the triceps, so that by dissecting these from above downward, it becomes very apparent, and more exteriorly fixed to the lateral ligaments. 3. It becomes below, posterior to the inferior ligament of the rotula, and is separated from it by an abundant packet of fat, jutting into the articulation, where it would be contained without it; there it sends from before backward to the space between the two condyles, a process improperly designated under the name of adipose ligament; it is a real canal, which may receive a probe between its sunken walls, and which then disappears over the condyles, by continuing with the portion of synovial membrane which lines them. 4. It is reflected over the articular surface of the tibia, and the two semi-lunar ligaments which it embraces by their two faces and their internal circumference, the external not being covered, except even with the passage of the popliteus on the outside of these two ligaments, which are thus without the cavity which the synovia lubricates. 5. It rises up before the crucial ligaments, is very perceptible on them, lines the fat contained in the interval of the condyles, and which is wholly situated without the articulation. 6. Returns at last over the condyles, after having previously covered the tendons of the gastrocnemii and popliteus, and is spread over the articular surface of the femur, being continued afterward behind the extensor, whence we have supposed it to originate.

Besides, this articulation, manifestly destitute of

fibrous capsule, is pretty strongly tied down by the tendons which pass round it, the ligaments which are stretched from one articulating surface to the other, and the expansion of the aponeurosis of the triceps. No articulation is better suited to give a general idea of the synovial membrane, which is here insulated through large spaces, and easy to distinguish in all parts where it is reflected.

95. *The humero-cubital articulation.* Accurately to dissect the synovial membrane of this joint, it is requisite, as in the preceding case, to turn over the tendon of the extensors. We then see it, 1. stretched from the cavity of the olecranon, which it covers at the apophysis of the same name, free from all adhesion, merely covered by fat cellular tissue, and by some accessory fibres; 2. it extends into the sigmoid cavity, lines it, as well as the superior part of the radius; 3. descends between these two bones, lining the inner part of the annular ligament, then leaving it and extending lower down along the neck of the radius, over which it is then reflected, forming a semicircular cul-de-sac; we easily see it passing beyond the annular ligament, in dissecting from below upward the supinator brevis which covers these parts; 4. mounts up behind the fibrous ligaments situated before the articulation, from which it is separated by an adipose tissue, and whose intervals often leave it visible; 5. is reflected over the coronoid cavity, then going to the olecranal cavity, whence it has been supposed to take its origin.

96. The two preceding articulations, essentially

analogous, both by their movement, the place they occupy in the limb, and by the arrangement of the surrounding organs, present however a difference sufficiently observable.

Their flexion and extension are performed in a direction exactly opposite, so that the motion, which in one is carried forward, in the other is directed backward, and the contrary.

The reason of this disposition is easily apprehended. In fact, every considerable motion of the superior extremities, is that of flexion; it is anteriorly then, that this flexion was to correspond, so that the organs of the surface might regulate its motions; but on the other hand, let us remark, that almost all exert an influence on the trunk, and tend also to carry it a little forward; if therefore the bending of the leg had been in this direction, the weight of the body, at the least effort, causing this articulation to bend, the centre of gravity would have been carried too far forward, and at the least exertion, falling would have taken place; on the contrary, the extension of the leg limiting its movements forward, it affords a solid support, which transmits, without fear from vascillations, the centre of gravity on the basis of sustentation.

97. I have also considered how it is that in semiflexion, circumduction is very extensive in the knee, very little in the elbow. It is because the crucial ligaments, which perform the functions which are accomplished by the olecranon in the elbow, at that moment loosely unite the articulating surfaces, while on the contrary, more close against them, the olecranon,

which is the last centre of these movements, permits them with difficulty. But let us return to our articulations.

98. *The tibio-astragalian articulation.* This articulation is tied down before by a fibrous layer descending from the tibia, over the sides, and particularly on the outside, by strong ligaments originating from the ankle bones, in different points of its circumference, by several tendinous sheaths. The capsule is spread over all these parts, over the surface of the astragalus, and over those of the tibia and fibula united.

It is very distinct in the interval of the ligaments, surrounded where they have but little adipose tissue, loosely united before, strongly adherent to the lateral ligaments.

99. *The phalangian articulations.* The phalanges of the toes and fingers are articulated between themselves by means of a double condyle received into a double cavity.

Their synovial membrane pursues this course: 1. it is free behind the extensor tendon, where it is seen by turning this back; it lines the posterior part of the tendon; 2. descends over the lower articulating surface, lining its lateral ligaments; 3. rises to the superior surface in passing over a ligamentous pad, transversely situated before the joint; 4. forms before the superior phalanx a very extensive cul-de-sac, embracing nearly the lower third of its anterior face and singularly favouring flexion; 5. returns over the condyles of the upper articulating face, thence passing over the extensor tendon.

100. I believe no one ever mentioned the fibrous pad, with cross fibres, of which I have spoken above; free at its edges, it is fixed at its extremities, on the sides of the joint, securing it from the impression of the flexors; it is embraced by the synovial capsule of this tendon before, behind by that of the joint.

101. *The costo-vertebral articulation.* It is almost as difficult to distinguish the synovial membrane here as in the sternal articulation of the ribs; it seems to exist however, embracing the summit of the rib, the two vertebral faces and the middle ligament. Several ligaments conceal it.

§. 5. *Moveable and limited articulations, with uniform surfaces.* [Lateral Ginglymus.]

102. This species of articulations has two varieties; in one, two articulating faces, situated at the two ends of the bone, serve to roll it on that which supports it.

A single face is found in the other, or if there are two of them, they are on the same level.

1st. VARIETY.

103. *The altoido-odontoid articulation.* Two small synovial capsules connect the anterior and posterior articulating faces of the odontoid process, with the corresponding faces of the atlas and transverse ligament, extended back of this apothysis. No fibre strengthens this weak articulation, which is always pretty fully supplied with synovia.

2d. VARIETY.

104. *The radio-cubital articulation.* I have related, when treating of the elbow joint, how the synovial capsule is applied in order to embrace the upper head of the radius. Downward, its articulation with the cubitus, presents a small synovial sack, expanded, 1. over the cartilaginous extremity of the cubitus, and over the inner face of the neck which supports it; 2. over the cubital surface of the inter-articular ligament; 3. over the adipose tissue, situated about the joint; here are few accessory fibres; the synovial capsule is almost alone, and is very easily distinguished. The inter-articular ligament is wedged in between this membrane and that of the wrist, and is not continued to them by its circumference.

THE END.

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END OF THE TABLE.

The reader is desired to correct the following

ERRATA.

Pag. ix, l. 7, for 1801 *read* 1802.
xiii, l. 1, — Bordue — Bordeu.
xiv, l. 8, — with him — him with.
25, l. 10, — groove — grooves.
27, l. 28, — over — through.
30, l. 19, *after* muscles, *add* of the face.
31, l. 22, *for* mucous *read* muscular.
32, l. 6, — delatation — dilatation.
34, l. 6, — this — their.
35, l. 7, *after* bodies, *add* are.
38, l. 14, *for* excressences *read* excrescences.
39, l. 2, — expoliating — exfoliating.
43, l. 22, — viscula — vesicula.
46, l. 21, — mucous — mucus.
48, note, l. 13, — jesunum — jejunum.
54, l. 13, — phenomina — phenomena.
— l. 19, — Sebatier — Sabatier.
71, l. 4, — hydrogin — hydrogen.
80, l. 7, — tendous — tendons.
137, l. 4, — Weitbrett — Weitbrect.
198, l. 17, — admire — admit.
220, l. 1, — wedge — wedged.
222, l. 15, — *after* or, *add* the.
243, l. 3, — *for* It becomes below, *read* It comes from below.
245, l. 23, — vascillations — vacillations.
For poritoneum *read* peritoneum,
— trachia — trachea,
— altoido — atloido,
wherever they occur.

This special edition of

A TREATISE
ON THE MEMBRANES

By Xavier Bichat

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